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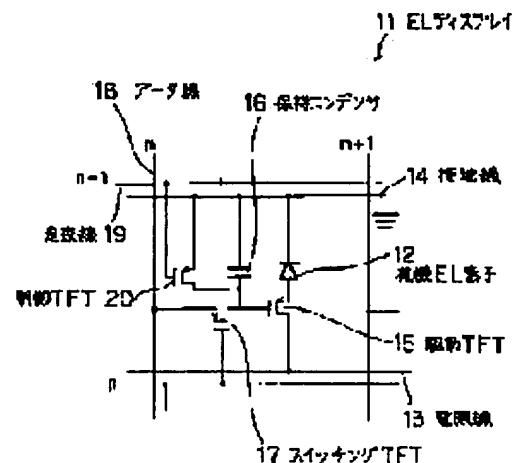
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## (54) METHOD AND DEVICE FOR IMAGE DISPLAY

### (57)Abstract:

**PROBLEM TO BE SOLVED:** To provide an image display device for active driving organic EL elements of M-lines and N-columns capable of prolonging the life of the organic EL elements.

**SOLUTION:** The driving voltage of a power line 13 is applied to an organic EL element 12 corresponding to the holding voltage of a holding condenser 16 to control light emission of an organic EL element 12 by active driving. In this case, the deriving voltage of the organic EL element 12 is stopped for a moment just before lighting control by discharging the holding voltage of the holding capacitor 16 on the (n) column at a timing of a scanning voltage on the (n-1) column.



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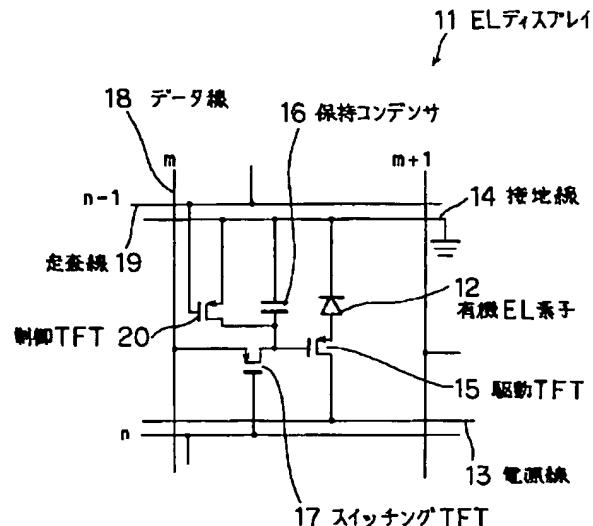
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## (54)【発明の名称】 画像表示方法および装置

## (57)【要約】

【課題】 M行N列の有機EL素子をアクティブ駆動する画像表示装置において、有機EL素子の寿命を延長する。

【解決手段】 保持コンデンサ16の保持電圧に対応して電源線13の駆動電圧を有機EL素子12に印加し、有機EL素子12をアクティブ駆動で発光制御する。ただし、第(n-1)列目の走査電圧のタイミングで第n列目の保持コンデンサ16の保持電圧を放電するなどし、有機EL素子12の駆動電圧を点灯制御の直前に一瞬だけ停止させる。



【特許請求の範囲】

【請求項1】 M行N列(MおよびNは各々所定の自然数)の二次元状に配列されている(M×N)個の有機EL(Electro-Luminescence)素子と、これら(M×N)個の前記有機EL素子の発光輝度が個々に設定されたデータ電圧が順番に印加されるM行のデータ線と、これらM行のデータ線に印加されるデータ電圧に同期して走査電圧が順番に入力されるN列の走査線と、これらN列の走査線に順番に入力される走査電圧により一列ずつオン状態とされるM行N列のスイッチング手段と、これらM行N列のスイッチング手段のオン状態に対応してM行の前記データ線から印加される(M×N)個のデータ電圧を個々に保持するM行N列の電圧保持手段と、所定の駆動電圧が常時印加されている一対の電源電極と、この電源電極に常時印加されている駆動電圧を(M×N)個の前記電圧保持手段の保持電圧に個々に対応して(M×N)個の前記有機EL素子に印加するM行N列の駆動トランジスタと、を具備している画像表示装置の画像表示方法であって、第n列目の前記走査線に走査電圧が入力される直前に第n列目のM個の前記有機EL素子への駆動電圧の印加を停止させるようにした画像表示方法。

【請求項2】 M行N列の二次元状に配列されている(M×N)個の有機EL素子と、これら(M×N)個の前記有機EL素子の発光輝度が個々に設定されたデータ電圧が順番に印加されるM行のデータ線と、これらM行のデータ線に印加されるデータ電圧に同期して走査電圧が順番に入力されるN列の走査線と、これらN列の走査線に順番に入力される走査電圧により一列ずつオン状態とされるM行N列のスイッチング手段と、これらM行N列のスイッチング手段のオン状態に対応してM行の前記データ線から印加される(M×N)個のデータ電圧を個々に保持するM行N列の電圧保持手段と、所定の駆動電圧が常時印加されている一対の電源電極と、この電源電極に常時印加されている駆動電圧を(M×N)個の前記電圧保持手段の保持電圧に個々に対応して(M×N)個の前記有機EL素子に印加するM行N列の駆動トランジスタと、を具備している画像表示装置の画像表示方法であって、第n列目の前記走査線に走査電圧が入力される直前に第n列目のM個の前記有機EL素子に駆動電圧とは極性が反対の反対電圧を印加させるようにした画像表示方法。

【請求項3】 M行N列の二次元状に配列されている(M×N)個の有機EL素子と、これら(M×N)個の前記有機EL素子の発光輝度が個々に設定されたデータ電圧が順番に印加されるM行のデータ線と、これらM行のデータ線に印加されるデータ電圧に同期して走査電圧が順番に入力されるN列の走査線と、これらN列の走査線に順番に入力される走査電圧により一列ずつオン状態とされるM行N列のスイッチング手段と、

これらM行N列のスイッチング手段のオン状態に対応してM行の前記データ線から印加される(M×N)個のデータ電圧を個々に保持するM行N列の電圧保持手段と、所定の駆動電圧が常時印加されている一対の電源電極と、

この電源電極に常時印加されている駆動電圧を(M×N)個の前記電圧保持手段の保持電圧に個々に対応して(M×N)個の前記有機EL素子に印加するM行N列の駆動トランジスタと、

第n列目の前記走査線に走査電圧が入力される直前に第n列目のM個の前記有機EL素子への駆動電圧の印加を停止させる通電制御手段と、を具備している画像表示装置。

【請求項4】 M行N列の二次元状に配列されている(M×N)個の有機EL素子と、これら(M×N)個の前記有機EL素子の発光輝度が個々に設定されたデータ電圧が順番に印加されるM行のデータ線と、

これらM行のデータ線に印加されるデータ電圧に同期して走査電圧が順番に入力されるN列の走査線と、これらN列の走査線に順番に入力される走査電圧により一列ずつオン状態とされるM行N列のスイッチング手段と、

これらM行N列のスイッチング手段のオン状態に対応してM行の前記データ線から印加される(M×N)個のデータ電圧を個々に保持するM行N列の電圧保持手段と、所定の駆動電圧が常時印加されている一対の電源電極と、

この電源電極に常時印加されている駆動電圧を(M×N)個の前記電圧保持手段の保持電圧に個々に対応して(M×N)個の前記有機EL素子に印加するM行N列の駆動トランジスタと、

第n列目の前記走査線に走査電圧が入力される直前に第n列目のM個の前記有機EL素子に駆動電圧とは極性が反対の反対電圧を印加させる通電制御手段と、を具備している画像表示装置。

【請求項5】 前記通電制御手段は、第(n-a)列目(aはNより小さい自然数)の前記走査線に走査電圧が入力されると第n列目の前記有機EL素子への駆動電圧の印加を停止させる請求項3記載の画像表示装置。

【請求項6】 前記通電制御手段は、第(n-a)列目の前記走査線に走査電圧が入力されると第n列目の前記有機EL素子に反対電圧を印加させる請求項4記載の画像表示装置。

【請求項7】 前記通電制御手段は、第(n-a)列目の前記走査線に走査電圧が入力されると第n列目の前記有機EL素子への駆動電圧の印加を停止させるとともに反対電圧を印加させる請求項4記載の画像表示装置。

【請求項8】 前記通電制御手段は、第(n-b)列目(bはaより大きくNより小さい整数)の前記走査線に走

査電圧が入力されると第n列目の前記有機EL素子への駆動電圧の印加を停止させ、第(n-a)列目の前記走査線に走査電圧が入力されると第n列目の前記有機EL素子に反対電圧を印加させる請求項4記載の画像表示装置。

【請求項9】 前記通電制御手段は、第(n-a)列目の前記走査線に走査電圧が入力されると第n列目の前記電圧保持手段の保持電圧を放電させる請求項5記載の画像表示装置。

【請求項10】 前記通電制御手段は、第(n-a)列目の前記走査線に走査電圧が入力されると第n列目の前記有機EL素子と前記電源電極との接続を切断する請求項5または9記載の画像表示装置。

【請求項11】 前記通電制御手段は、第(n-a)列目の前記走査線に入力される走査電圧を反対電圧として第n列目の前記有機EL素子に通電させる請求項6ないし8の何れか一記載の画像表示装置。

【請求項12】 前記通電制御手段は、第(n-b)列目の前記走査線に走査電圧が入力されると第n列目の前記電圧保持手段の保持電圧を放電させ、第(n-a)列目の前記走査線に入力される走査電圧を反対電圧として第n列目の前記有機EL素子に通電させる請求項8記載の画像表示装置。

【請求項13】 前記通電制御手段は、第(n-b)列目の前記走査線に走査電圧が入力されると第n列目の前記有機EL素子と前記電源電極との接続を切断し、第(n-a)列目の前記走査線に入力される走査電圧を反対電圧として第n列目の前記有機EL素子に通電させる請求項8記載の画像表示装置。

【請求項14】 “a = 1” であり、

前記通電制御手段は、第N列目の前記走査線に走査電圧が入力されると第一列目の前記有機EL素子の通電を制御する請求項5ないし7の何れか一記載の画像表示装置。

【請求項15】 “a = 1” であり、

第一列目の前記走査線に並設されて第一列目の走査電圧の直前にダミーの走査電圧が入力されるダミー線も具備しており、前記通電制御手段は、前記ダミー線に走査電圧が入力されると第一列目の前記有機EL素子の通電を制御する請求項5ないし7の何れか一記載の画像表示装置。

【請求項16】 “a = 1, b = 2” であり、

前記通電制御手段は、第(N-1)列目の前記走査線に走査電圧が入力されると第一列目の前記有機EL素子への駆動電圧の印加を停止させ、第N列目の前記走査線に走査電圧が入力されると第一列目の前記有機EL素子に反対電圧を印加させるとともに第二列目の前記有機EL素子への駆動電圧の印加を停止させる請求項8記載の画像表示装置。

【請求項17】 “a = 1, b = 2” であり、

第一列目の前記走査線に並設されて第一列目の走査電圧の直前にダミーの走査電圧が順番に入力される第一第二のダミー線も具備しており、

前記通電制御手段は、前記第一のダミー線に走査電圧が入力されると第一列目の前記有機EL素子への駆動電圧の印加を停止させ、前記第二のダミー線に走査電圧が入力されると第一列目の前記有機EL素子に反対電圧を印加させるとともに第二列目の前記有機EL素子への駆動電圧の印加を停止させる請求項8記載の画像表示装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】 本発明は、二次元状に配列された多数の有機EL素子をアクティブ駆動して画像を表示する画像表示方法および装置とに関する。

【0002】

【従来の技術】 現在、自動車の室内などの明暗が顕著に変化する場所で各種画像を表示する画像表示装置として、多数の有機EL素子を二次元状に配列させてドットマトリクスの画像を表示するELディスプレイが開発されている。有機EL素子は自発光する発光素子であり、低電圧の直流電流で駆動することができる。

【0003】 有機EL素子の駆動方法としてはパッシブ方式とアクティブ方式があるが、アクティブ方式は表示画像を更新するまで有機EL素子を連続的に点灯するので高輝度を高効率に実現することができる。ここで、画像表示装置の一従来例として有機EL素子をアクティブ駆動するELディスプレイを図14および図15を参照して以下に説明する。なお、図14は一従来例のELディスプレイの要部を示す回路図、図15は各部の信号波形を示すタイムチャートである。

【0004】 ここで一従来例として例示するELディスプレイ1は、図14に示すように、有機EL素子2を具備しており、一对の電源電極として電源線3と接地線4とを具備している。電源線3には所定の駆動電圧が常時印加されており、接地線4は基準電圧である“0”電圧に常時維持されている。

【0005】 有機EL素子2は、接地線4には直接に接続されているが、電源線3には駆動TFT(Thin Film Transistor)5を介して接続されている。この駆動TFT5はゲート電極を具備しており、電源線3から接地線4に印加される駆動電圧を、そのゲート電極に印加されるデータ電圧に対応して有機EL素子2に供給する。

【0006】 駆動TFT5のゲート電極には、電圧保持手段として保持コンデンサ6の一端が接続されており、この保持コンデンサ6の他端も接地線4に接続されている。また、この保持コンデンサ6および駆動TFT5のゲート電極には、スイッチング手段であるスイッチングTFT7を介してデータ線8が接続されており、このスイッチングTFT7のゲート電極には、走査線9が接続されている。

【0007】データ線8には、有機EL素子2の発光輝度を駆動制御するためのデータ電圧が供給され、走査線9には、スイッチングTFT7を動作制御するための走査電圧が入力される。保持コンデンサ6は、データ電圧を保持して駆動TFT5のゲート電極に印加し、スイッチングTFT7は、保持コンデンサ6とデータ線8との接続をオンオフする。

【0008】なお、ここで一従来例として例示するELディスプレイ1では、実際には( $M \times N$ )個の有機EL素子2がM行N列の二次元状に配列されており(図示せず)、このM行N列の有機EL素子2にM行のデータ線8とN列の走査線9とがマトリクス接続されている。また、ここでは図面で上下方向と平行な一次元を行、左右方向と平行な一次元を列、として行列を表現するが、これは定義の問題なので反対でも良い。

【0009】上述のような構造のELディスプレイ1は、有機EL素子2を可変自在な発光輝度で駆動制御することができる。その場合、図15(b)(c)に示すように、走査線9に走査電圧を入力してスイッチングTFT7をオン状態に動作制御し、同図(e)に示すように、この状態でデータ線8から有機EL素子2の発光輝度に対応したデータ電圧を保持コンデンサ6に供給して保持させる。

【0010】同図(d)に示すように、この保持コンデンサ6が保持したデータ電圧は駆動TFT5のゲート電極に印加されるので、同図(f)に示すように、電源線3と接地線4とに常時発生している駆動電圧が駆動TFT5によりゲート電圧に対応して有機EL素子2に供給されることになり、この有機EL素子2はデータ線8に供給されたデータ電圧に対応した輝度で発光することになる。

【0011】ELディスプレイ1では、M行のデータ線8とN列の走査線9とにデータ電圧と走査電圧とがマトリクス入力されるので、M行N列の有機EL素子2が個々に相違する輝度で点灯されることになり、画素単位で階調表現されたドットマトリクスの画像が表示される。

【0012】その場合、ELディスプレイ1では、図15(a)(b)に示すように、N列の走査線9には走査電圧が一列ずつ順番に入力されるので、この走査電圧が入力されているときに、M行のデータ線8に一列のM個のデータ電圧が順番に入力されることになる。

【0013】また、前述のように保持コンデンサ6が保持したデータ電圧に対応して有機EL素子2に駆動電圧が印加される状態は、走査線9の走査電圧によりスイッチングTFT7がオフ状態に動作制御されても継続される。このため、有機EL素子2は、所定の輝度で制御された点灯を次回の制御まで継続することになり、ELディスプレイ1は画像を高輝度かつ高コントラストに表示することができる。

【0014】

【発明が解決しようとする課題】上述のようなELディスプレイ1では、M行N列の有機EL素子2を個々に所望の輝度で点灯させて多階調の画像を表示することができ、特に、所望の電圧に制御した有機EL素子2の駆動電圧の印加を次回の制御まで継続させることができるので、有機EL素子2を連続的に点灯させて画像を高輝度に表示することができる。

【0015】しかし、上述のようにアクティブ駆動するELディスプレイ1では、有機EL素子2が短寿命である。その理由は各種が想定されているが、特性的に有機EL素子2は同一極性の駆動電圧が連続的に印加されると短寿命となることが判明している。

【0016】例えば、有機EL素子2をパッシブ駆動するELディスプレイ(図示せず)では、その駆動過程で有機EL素子2に印加される電圧の極性が反転されるため、アクティブ駆動の場合に比較して有機EL素子2が長寿命となることが確認されている。しかし、前述のようにパッシブ方式のELディスプレイでは、有機EL素子2を高輝度かつ高効率に点灯できないため、高輝度が要望される装置に利用することが困難である。

【0017】本発明は上述のような課題に鑑みてなされたものであり、有機EL素子をアクティブ駆動で高輝度かつ高効率に点灯しながらも長寿命とすることができる画像表示方法および装置を提供することを目的とする。

【0018】

【課題を解決するための手段】本発明の一の画像表示装置は、M行N列の二次元状に配列されている( $M \times N$ )個の有機EL素子と、これら( $M \times N$ )個の前記有機EL素子の発光輝度が個々に設定されたデータ電圧が順番に印加されるM行のデータ線と、これらM行のデータ線に印加されるデータ電圧に同期して走査電圧が順番に入力されるN列の走査線と、これらN列の走査線に順番に入力される走査電圧により一列ずつオン状態とされるM行N列のスイッチング手段と、これらM行N列のスイッチング手段のオン状態に対応してM行の前記データ線から印加される( $M \times N$ )個のデータ電圧を個々に保持するM行N列の電圧保持手段と、所定の駆動電圧が常時印加されている一対の電源電極と、この電源電極に常時印加されている駆動電圧を( $M \times N$ )個の前記電圧保持手段の保持電圧に個々に対応して( $M \times N$ )個の前記有機EL素子に印加するM行N列の駆動トランジスタと、第n列目の前記走査線に走査電圧が入力される直前に第n列目のM個の前記有機EL素子への駆動電圧の印加を停止させる通電制御手段と、を具備している。

【0019】従って、本発明の画像表示装置による画像表示方法では、( $M \times N$ )個の有機EL素子がM行N列の二次元状に配列されている状態で、これら( $M \times N$ )個の有機EL素子の発光輝度が個々に設定された( $M \times N$ )個のデータ電圧がM行のデータ線の各々に順番にN個ずつ印加され、これらM行のデータ線に印加されるデータ電

圧に同期してN列の走査線に走査電圧が順番に入力される。これらN列の走査線に順番に入力される走査電圧によりM行N列のスイッチング手段が一列ずつオン状態とされ、これらM行N列のスイッチング手段のオン状態に対応してM行のデータ線から印加される( $M \times N$ )個のデータ電圧をM行N列の電圧保持手段が個々に保持する。電源電極に常時印加されている駆動電圧を( $M \times N$ )個の電圧保持手段の保持電圧に個々に対応してM行N列の駆動トランジスタが( $M \times N$ )個の有機EL素子に印加するので、これでM行N列の有機EL素子が個々に相違する輝度でアクティブ駆動されてドットマトリクスの多階調の画像が表示される。ただし、第n列目の走査線に走査電圧が入力される直前に第n列目のM個の有機EL素子への駆動電圧の印加を通電制御手段が停止させるので、同一輝度の画像が連続的に表示される場合でもアクティブ駆動される有機EL素子の通電が画像の表示制御の直前に一瞬だけ停止される。

【0020】本発明の他の画像表示装置は、M行N列の二次元状に配列されている( $M \times N$ )個の有機EL素子と、これら( $M \times N$ )個の前記有機EL素子の発光輝度が個々に設定されたデータ電圧が順番に印加されるM行のデータ線と、これらM行のデータ線に印加されるデータ電圧に同期して走査電圧が順番に入力されるN列の走査線と、これらN列の走査線に順番に入力される走査電圧により一列ずつオン状態とされるM行N列のスイッチング手段と、これらM行N列のスイッチング手段のオン状態に対応してM行の前記データ線から印加される( $M \times N$ )個のデータ電圧を個々に保持するM行N列の電圧保持手段と、所定の駆動電圧が常時印加されている一対の電源電極と、この電源電極に常時印加されている駆動電圧を( $M \times N$ )個の前記電圧保持手段の保持電圧に個々に対応して( $M \times N$ )個の前記有機EL素子に印加するM行N列の駆動トランジスタと、第n列目の前記走査線に走査電圧が入力される直前に第n列目のM個の前記有機EL素子に駆動電圧とは極性が反対の反対電圧を印加する通電制御手段と、を具備している。

【0021】従って、本発明の画像表示装置による画像表示方法では、( $M \times N$ )個の有機EL素子がM行N列の二次元状に配列されている状態で、これら( $M \times N$ )個の有機EL素子の発光輝度が個々に設定された( $M \times N$ )個のデータ電圧がM行のデータ線の各々に順番にN個ずつ印加され、これらM行のデータ線に印加されるデータ電圧に同期してN列の走査線に走査電圧が順番に入力される。これらN列の走査線に順番に入力される走査電圧によりM行N列のスイッチング手段が一列ずつオン状態とされ、これらM行N列のスイッチング手段のオン状態に対応してM行のデータ線から印加される( $M \times N$ )個のデータ電圧をM行N列の電圧保持手段が個々に保持する。電源電極に常時印加されている駆動電圧を( $M \times N$ )個の電圧保持手段の保持電圧に個々に対応してM行N列の駆

動トランジスタが( $M \times N$ )個の有機EL素子に印加するので、これでM行N列の有機EL素子が個々に相違する輝度でアクティブ駆動されてドットマトリクスの多階調の画像が表示される。ただし、第n列目の走査線に走査電圧が入力される直前に通電制御手段が第n列目のM個の有機EL素子に駆動電圧とは極性が反対の反対電圧を印加させるので、同一輝度の画像が連続的に表示される場合でもアクティブ駆動される有機EL素子に印加される電圧の極性が画像の表示制御の直前に一瞬だけ反転される。

【0022】上述のような画像表示装置において、前記通電制御手段は、第(n-a)列目の前記走査線に走査電圧が入力されると第n列目の前記有機EL素子への駆動電圧の印加を停止させることも可能である。この場合、第(n-a)列目の走査線に走査電圧が入力されると通電制御手段が第n列目の有機EL素子への駆動電圧の印加を停止させるので、第n列目の走査線に走査電圧が入力される直前に第n列目のM個の有機EL素子への駆動電圧の印加を停止させることが、所望のタイミングで簡単かつ確実に実行される。

【0023】上述のような画像表示装置において、前記通電制御手段は、第(n-a)列目の前記走査線に走査電圧が入力されると第n列目の前記有機EL素子に反対電圧を印加させることも可能である。この場合、第(n-a)列目の走査線に走査電圧が入力されると通電制御手段が第n列目の有機EL素子に反対電圧を印加させるので、第n列目の走査線に走査電圧が入力される直前に第n列目のM個の有機EL素子に駆動電圧とは極性が反対の反対電圧を印加させることが、所望のタイミングで簡単かつ確実に実行される。

【0024】上述のような画像表示装置において、前記通電制御手段は、第(n-a)列目の前記走査線に走査電圧が入力されると第n列目の前記有機EL素子への駆動電圧の印加を停止させるとともに反対電圧を印加させることも可能である。この場合、第(n-a)列目の走査線に走査電圧が入力されると通電制御手段が第n列目の有機EL素子への駆動電圧の印加を停止させて反対電圧を印加させるので、第n列目の走査線に走査電圧が入力される直前に第n列目のM個の有機EL素子に駆動電圧とは極性が反対の反対電圧を印加させることが、所望のタイミングで簡単かつ確実に実行される。

【0025】上述のような画像表示装置において、前記通電制御手段は、第(n-b)列目(bはaより大きくNより小さい整数)の前記走査線に走査電圧が入力されると第n列目の前記有機EL素子への駆動電圧の印加を停止させ、第(n-a)列目の前記走査線に走査電圧が入力されると第n列目の前記有機EL素子に反対電圧を印加させることも可能である。

【0026】この場合、第(n-b)列目の走査線に走査電圧が入力されると通電制御手段が第n列目の有機EL

素子への駆動電圧の印加を停止させ、第(n-a)列目の走査線に走査電圧が入力されると第n列目の有機EL素子に反対電圧を印加させるので、有機EL素子への反対電圧の通電は駆動電圧の印加が確実に停止されてから実行される。

【0027】上述のような画像表示装置において、前記通電制御手段は、第(n-a)列目の前記走査線に走査電圧が入力されると第n列目の前記電圧保持手段の保持電圧を放電させることも可能である。この場合、第(n-a)列目の前記走査線に走査電圧が入力されると通電制御手段が第n列目の電圧保持手段の保持電圧を放電させるので、有機EL素子への駆動電圧の印加を停止させることが電圧保持手段の動作制御により実現される。

【0028】上述のような画像表示装置において、前記通電制御手段は、第(n-a)列目の前記走査線に走査電圧が入力されると第n列目の前記有機EL素子と前記電源電極との接続を切断することも可能である。この場合、第(n-a)列目の前記走査線に走査電圧が入力されると通電制御手段が第n列目の有機EL素子と電源電極との接続を切断するので、有機EL素子への駆動電圧の印加を停止させることが確実に実行される。

【0029】上述のような画像表示装置において、前記通電制御手段は、第(n-a)列目の前記走査線に入力される走査電圧を反対電圧として第n列目の前記有機EL素子に通電させることも可能である。この場合、第(n-a)列目の走査線に入力される走査電圧を通電制御手段が反対電圧として第n列目の有機EL素子に通電させるので、有機EL素子に通電させる反対電圧として走査電圧が利用される。

【0030】上述のような画像表示装置において、前記通電制御手段は、第(n-b)列目の前記走査線に走査電圧が入力されると第n列目の前記電圧保持手段の保持電圧を放電させ、第(n-a)列目の前記走査線に入力される走査電圧を反対電圧として第n列目の前記有機EL素子に通電させることも可能である。

【0031】この場合、第(n-b)列目の走査線に走査電圧が入力されると通電制御手段が第n列目の電圧保持手段の保持電圧を放電させ、第(n-a)列目の走査線に入力される走査電圧を反対電圧として第n列目の有機EL素子に通電させるので、電圧保持手段の動作制御により有機EL素子への駆動電圧の印加が停止され、この通電電流が停止された有機EL素子に走査電圧が反対電圧として通電される。

【0032】上述のような画像表示装置において、前記通電制御手段は、第(n-b)列目の前記走査線に走査電圧が入力されると第n列目の前記有機EL素子と前記電源電極との接続を切断し、第(n-a)列目の前記走査線に入力される走査電圧を反対電圧として第n列目の前記有機EL素子に通電させることも可能である。

【0033】この場合、第(n-b)列目の走査線に走査

電圧が入力されると通電制御手段が第n列目の有機EL素子と電源電極との接続を切断し、第(n-a)列目の走査線に入力される走査電圧を反対電圧として第n列目の有機EL素子に通電させるので、電源電極の切断により有機EL素子への駆動電圧の印加が停止され、この通電電流が停止された有機EL素子に走査電圧が反対電圧として通電される。

【0034】上述のような画像表示装置において、“a = 1”であり、前記通電制御手段は、第N列目の前記走査線に走査電圧が入力されると第一列目の前記有機EL素子の通電を制御することも可能である。この場合、

“a = 1”なので一列前の走査線に走査電圧が入力されると通電制御手段が有機EL素子の通電を制御するが、第一列目の前記有機EL素子の通電は最終列である第N列目の走査線に走査電圧が入力されると制御される。

【0035】上述のような画像表示装置において、“a = 1”であり、第一列目の前記走査線に並設されて第一列目の走査電圧の直前にダミーの走査電圧が入力されるダミー線も具備しており、前記通電制御手段は、前記ダミー線に走査電圧が入力されると第一列目の前記有機EL素子の通電を制御することも可能である。

【0036】この場合、“a = 1”なので一列前の走査線に走査電圧が入力されると通電制御手段が有機EL素子の通電を制御するが、第一列目の走査線に並設されたダミー線にダミーの走査電圧が第一列目の走査電圧の直前に入力されるので、第一列目の有機EL素子の通電はダミー線にダミーの走査電圧が入力されると制御される。

【0037】上述のような画像表示装置において、“a = 1, b = 2”であり、前記通電制御手段は、第(N-1)列目の前記走査線に走査電圧が入力されると第一列目の前記有機EL素子への駆動電圧の印加を停止させ、第N列目の前記走査線に走査電圧が入力されると第一列目の前記有機EL素子に反対電圧を印加するとともに第二列目の前記有機EL素子への駆動電圧の印加を停止させることも可能である。

【0038】この場合、“a = 1, b = 2”なので二列前の走査線に走査電圧が入力されると通電制御手段が有機EL素子に印加される駆動電圧を停止させ、一列前の走査線に走査電圧が入力されると有機EL素子に反対電圧を印加させる。ただし、第一列目の有機EL素子は第(N-1)列目の走査線に走査電圧が入力されると駆動電圧が停止され、第N列目の走査線に走査電圧が入力されると反対電圧が通電される。第二列目の有機EL素子は第N列目の走査線に走査電圧が入力されると駆動電圧が停止される。

【0039】上述のような画像表示装置において、“a = 1, b = 2”であり、第一列目の前記走査線に並設されて第一列目の走査電圧の直前にダミーの走査電圧が順番に入力される第一第二のダミー線も具備しており、前

記述電制御手段は、前記第一のダミー線に走査電圧が入力されると第一列目の前記有機EL素子への駆動電圧の印加を停止させ、前記第二のダミー線に走査電圧が入力されると第一列目の前記有機EL素子に反対電圧を印加させるとともに第二列目の前記有機EL素子への駆動電圧の印加を停止させることも可能である。

【0040】この場合、“ $a = 1, b = 2$ ”なので二列前の走査線に走査電圧が入力されると通電制御手段が有機EL素子に印加される駆動電圧を停止させ、一列前の走査線に走査電圧が入力されると有機EL素子に反対電圧を印加させる。ただし、第一列目の走査線に並設された第一第二のダミー線に第一第二のダミーの走査電圧が第一列目の走査電圧の直前に入力されるので、第一列目の有機EL素子は第一のダミー線に走査電圧が入力されると駆動電圧が停止され、第二のダミー線に走査電圧が入力されると反対電圧が通電される。第二列目の有機EL素子は第二のダミー線に走査電圧が入力されると駆動電圧が停止される。

【0041】なお、本発明で云う各種手段は、その機能を実現するように形成されれば良く、例えば、専用のハードウェア、適正な機能がプログラムにより付与されたコンピュータ、適正なプログラムによりコンピュータの内部に実現された機能、これらの組み合わせ、等を許容する。

#### 【0042】

【発明の実施の形態】本発明の実施の第一の形態を図1ないし図4を参照して以下に説明する。ただし、本実施の形態に関して前述した一従来例と同一の部分は、同一の名称を使用して詳細な説明は省略する。また、ここでも図面で上下方向と平行な一次元を行、左右方向と平行な一次元を列、として行列を表現するが、これは説明を簡略化するために便宜的に定義するものであり、反対の呼称を拒絶するものではない。

【0043】なお、図1は本発明の画像表示装置の実施の第一の形態であるELディスプレイの要部の回路構造を示す回路図、図2はELディスプレイの全体構造を示すブロック図、図3は有機EL素子の部分の薄膜構造を示す断面図、図4はELディスプレイの各部の信号波形を示すタイムチャート、である。

【0044】本実施の形態のELディスプレイ11も、図1に示すように、一従来例のELディスプレイ1と同様に、 $(M \times N)$ 個の有機EL素子12を具備しており、図2に示すように、この $(M \times N)$ 個の有機EL素子12がM行N列の二次元状に配列されている。

【0045】なお、本実施の形態のELディスプレイ11は、いわゆるVGA(Video Graphics Array)規格に対応しており、RGB(Red, Green, Blue)方式でカラー画像を表示出力するので、 $(480 \times 1980)$ 個の有機EL素子12が480行1980列に配列されている。

【0046】本実施の形態のELディスプレイ11も、

一対の電源電極として電源線13と接地線14とを具備しており、有機EL素子12は、接地線14には直接に接続されており、電源線13には駆動トランジスタである駆動TFT15を介して接続されている。

【0047】この駆動TFT15のゲート電極には、電圧保持手段として保持コンデンサ16が接続されており、この保持コンデンサ16も接地線14に接続されている。この保持コンデンサ16および駆動TFT15のゲート電極には、スイッチング手段であるスイッチングTFT17のドレイン電極が接続されており、このスイッチングTFT17は、ソース電極にデータ線18が接続されるとともにゲート電極に走査線19が接続されている。

【0048】しかし、本実施の形態のELディスプレイ11は、一従来例のELディスプレイ1とは相違して、“5.0(V)”の矩形パルスの走査電圧が第n列目の走査線19に入力される直前に第n列目のM個の有機EL素子12への駆動電圧の印加を停止させる通電制御手段として、M行N列の制御TFT20がM行N列の有機EL素子12の一個ごとに一個ずつ設けられている。

【0049】この制御TFT20は、ドレイン電極が保持コンデンサ16と駆動TFT15との接続配線に接続されており、ソース電極が接地線14に接続されている。ただし、第n列目のM個の制御TFT20のゲート電極は、第(n-1)列目の走査線19に接続されているので、第(n-1)列目の走査線19に走査電圧が入力されると第n列目の保持コンデンサ16の“5.0~0.0(V)”の保持電圧を放電させる。

【0050】ただし、“n=1”となる第一列目の制御TFT20に対しては、第(n-1)列目の走査線19が存在しない。そこで、本実施の形態のELディスプレイ11では、図2に示すように、ダミー線21が第一列目の走査線19に並設されており、このダミー線21に第一列目のM個の制御TFT20のゲート電極が接続されている。

【0051】そして、N列の走査線19と一列のダミー線21とは一個の走査駆動回路22に接続されており、この走査駆動回路22は、 $(N+1)$ 個の走査電圧を一画面の表示ごとに一列のダミー線21とN列の走査線19とに順番に入力するので、ダミー線21には、第一列目の走査線19に走査電圧が入力される直前にダミーの走査電圧が入力される。

【0052】なお、M行のデータ線18は一個のデータ駆動回路23に接続されており、このデータ駆動回路23は、一画面の表示ごとに $(M \times N)$ 個の“5.0~0.0(V)”のデータ電圧をM行のデータ線18の各々にN個の走査電圧に同期して順番に印加するので、一列ごとにM個の保持コンデンサ16にM個のデータ電圧が順番に保持される。

【0053】本実施の形態のELディスプレイ11で

も、図2および図3に示すように、上述した有機EL素子12などの各部が、一個のガラス基板30の一面に層膜構造で形成されている。より詳細には、図3に示すように、駆動TFT15や制御TFT20は、ガラス基板30の面上に積層されたp-Si製のアイランド31上に形成されており、このアイランド31上にゲート酸化膜32が積層されている。

【0054】このゲート酸化膜32の中央部分にはアルミニウム等の金属製のゲート電極33が積層されており、その両側にはソース電極34とドレイン電極35とが接続されている。これらの電極34、35は電源線13や接地線14と一緒に形成されており、上述のような構造は絶縁層36で一様に封入されている。

【0055】有機EL素子12は、絶縁層36の上面に形成されており、この絶縁層36の面上にはITO(Indium Tin Oxide)製の陽極41が積層されている。この陽極41上には、正孔輸送層42、発光層43、電子輸送層44、金属製の陰極45、が順番に積層されており、これらで有機EL素子12が形成されている。

【0056】なお、上述のような絶縁層36は要所にコンタクトホールが形成されており、このコンタクトホールにより、有機EL素子12の陽極41と駆動TFT15のソース電極34とが接続されており、陰極45と接地線14とが接続されている。

【0057】本実施の形態のELディスプレイ11は、上述のようにM行N列の有機EL素子12に各種線13、14…や各種素子15、16…や各種回路22、23等を接続したものであり、外部入力される画像データに対応して画像を表示する。有機EL素子12は、図3に示すように、発光層43等で形成されているが、図2に示すように、ELディスプレイ11のM行N列の画素領域に対応した形状に各々形成されている。

【0058】上述のような構成において、本実施の形態のELディスプレイ11も、一従来例のELディスプレイ1と同様に、M行N列の有機EL素子12を個々に所望の輝度で発光させて画素単位で多階調のドットマトリクス画像を表示することができ、特に、有機EL素子12を個々にアクティブ駆動するので高効率に高輝度を実現することができる。

【0059】その場合、図4に示すように、N列の走査線19に走査電圧が順番に入力されてM行N列のスイッチングTFT17が一列ずつ順番にオン状態とされるので、その一列のM個の有機EL素子12の発光輝度に対応したデータ電圧がM行のデータ線18に個々に印加される。

【0060】すると、このM個のデータ電圧はスイッチングTFT17を介して一列のM個の保持コンデンサ16に個々に保持され、この保持コンデンサ16の保持電圧は一列のM個の駆動TFT15のゲート電極に個々に印加されるので、電源線13に常時印加されている駆動

電圧が駆動TFT15により一列のM個の有機EL素子12に供給される。

【0061】その電流量は保持コンデンサ16から駆動TFT15のゲート電極に印加される電圧に対応するので、一列のM個の有機EL素子12がデータ線18に供給された制御電流に対応した輝度で発光することになり、この動作状態は走査電圧がオフ状態となっても保持コンデンサ16の保持電圧により維持される。

【0062】上述のような動作がN列の走査線19ごとに順番に実行されるので、本実施の形態のELディスプレイ11は、M行N列の有機EL素子12を個々に所望の輝度で発光させて画素単位で階調表現されたドットマトリクスの画像を表示することができる。しかも、有機EL素子12の発光状態は保持コンデンサ16の保持電圧により次回の発光制御まで維持されるので、高効率に高輝度が実現される。

【0063】ただし、本実施の形態のELディスプレイ11では、上述のように有機EL素子12をアクティブ駆動するが、有機EL素子12の通電を発光制御の直前に一瞬だけ停止させる。つまり、第(n-1)列目の走査線19に走査電圧が入力されるとき、その走査電圧により第n列目の制御TFT20をオン状態として第n列目の保持コンデンサ16の両端を接地線14に接続し、第n列目の有機EL素子12の通電を停止させる。

【0064】このため、本実施の形態のELディスプレイ11では、アクティブ駆動により有機EL素子12の発光状態を次回の発光制御まで維持するが、その発光制御の直前に有機EL素子12の通電を一瞬だけ停止せることで、アクティブ駆動する有機EL素子12の寿命を延長することができる。

【0065】特に、有機EL素子12の通電を一時停止させることを一列前の走査線19の走査電圧で制御するので、有機EL素子12の通電を最適なタイミングで確実に制御することができる。しかも、第一列目の走査線19の手前にはダミー線21が並設されており、このダミー線21に入力するダミーの走査電圧により第一列目の有機EL素子12の通電を停止させるので、M行N列の有機EL素子12の全部の通電を最適なタイミングで確実に制御することができる。

【0066】なお、本発明は上記形態に限定されるものではなく、その要旨を逸脱しない範囲で各種の変形を許容する。例えば、上記形態では第n列目の有機EL素子12の通電を第(n-1)列目の走査線19の走査電圧のタイミングで一時停止させることを例示したが、これを第(n-a)列目の走査線19の走査電圧のタイミングとすることも可能である。ただし、“a”を二以上とすると、ダミー線21の本数も増加させる必要があり、有機EL素子12が消灯する時間も増加して全体の輝度が低下するので、一般的には“a=1”とすることが最適である。

【0067】また、上記形態では第一列目の走査線19にダミー線21を並設してダミーの走査電圧を入力することを例示したが、最終列である第N列目の走査線19を第一列目の制御TFT20に接続し、第N列目の走査線19に入力される走査電圧で第一列目の有機EL素子12の通電を一時停止させることも可能である。

【0068】ダミー線21を追加する構造では、ダミー線21や走査駆動回路22の内部回路を追加する必要があるが、面倒な配線の引き回しは無用である。第N列目の走査線19を第一列目の制御TFT20に接続する構造では、配線の引き回しが面倒な可能性はあるが、ダミー線21や走査駆動回路22の内部回路の追加は無用である。つまり、これらは相互に一長一短を有するので、実際に装置を実施する場合には各種条件を考慮して最適な一方を選択することが好適である。

【0069】さらに、上記形態ではM行N列の有機EL素子12の通電を制御するために制御TFT20もM行N列に配列することを例示した。しかし、制御TFT20は走査電圧ごとに一列のM個の有機EL素子12の通電を制御できれば良いので、例えば、N列の走査線19の一本と一列のM個の有機EL素子12とにN個の制御TFT20を一個ずつ接続することも可能である。

【0070】制御TFT20もM行N列に配列する構造では、回路規模が増大するが、面倒な配線の引き回しは無用であり、制御TFT20をN列のみ配列する構造では、配線の引き回しが面倒な可能性はあるが、回路規模を削減することができるので、これらも実際には最適な一方を選択することが好適である。

【0071】なお、ELディスプレイ11を実際に製造する場合には同一パターンの薄膜回路をM行N列に形成するので、制御TFT20もM行N列に配列する構造は製造が容易である。そこで、制御TFT20をN列のみ配列する場合は、その制御TFT20を画素領域の外側で各列の端部などに位置させて別個に形成することが好適である。

【0072】つぎに、本発明の実施の第二の形態を図5および図6を参照して以下に説明する。ただし、これより以下の実施の形態では、それ以前の実施の形態と同一の部分は、同一の名称および符号を使用して詳細な説明は省略する。なお、図5は実施の第二の形態のELディスプレイの要部の回路構造を示す回路図、図6は各部の信号波形を示すタイムチャート、である。

【0073】本実施の形態のELディスプレイ51では、図5に示すように、第n列目の走査線19に走査電圧が入力される直前に第n列目のM個の有機EL素子12への駆動電圧の印加を停止させる通電制御手段として、M行N列の第一の制御TFT20とともに第二の制御TFT52もM行N列の有機EL素子12の一端ごとに個別に設けられている。

【0074】第n列目の第二の制御TFT52は、ゲー

ト電極が第(n-1)列目の走査線19に接続されており、両端が有機EL素子12の両端に接続されている。なお、この第二の制御TFT52も、第一列目ではゲート電極がダミー線21に接続されている。

【0075】上述のような構成において、本実施の形態のELディスプレイ51も、第一の形態として前述したELディスプレイ11と同様に、アクティブ駆動する有機EL素子12の通電を発光制御の直前に一瞬だけ停止させる。その場合、図6に示すように、第(n-1)列目の走査線19に入力される走査電圧により第n列目の第一第二の制御TFT20、52の両方をオン状態とし、第n列目の保持コンデンサ16の両端を接地線14に接続するとともに、第n列目の有機EL素子12の両端を短絡させる。

【0076】このため、本実施の形態のELディスプレイ51では、より確実に有機EL素子12の通電を一時停止させることができ、より良好にアクティブ駆動する有機EL素子12の寿命を延長することができる。なお、上述の第二の制御TFT52も、M行N列でなくN列のみとすることが可能である。

【0077】つぎに、本発明の実施の第三の形態を図7および図8を参照して以下に説明する。なお、図7は実施の第二の形態のELディスプレイの要部の回路構造を示す回路図、図8は各部の信号波形を示すタイムチャート、である。

【0078】本実施の形態のELディスプレイ61では、図7に示すように、M行N列の第一の制御TFT20とともに制御コンデンサ62も、通電制御手段としてM行N列の有機EL素子12の一端ごとに個別に設けられている。

【0079】第n列目の制御コンデンサ62は、一端が第(n-1)列目の走査線19に接続されており、他端が有機EL素子12と駆動TFT15との接点に接続されている。なお、この制御コンデンサ62も、第一列目では一端がダミー線21に接続されている。

【0080】上述のような構成において、本実施の形態のELディスプレイ61では、図6に示すように、第(n-1)列目の走査線19に入力される走査電圧により、第n列目の制御TFT20をオン状態にするとともに、制御コンデンサ62の一端に走査電圧の電圧を印加する。

【0081】すると、図8に示すように、制御コンデンサ62は他端に極性が反対のスパイクノイズを発生するので、これが駆動電圧とは極性が反対の反対電圧として有機EL素子12に通電される。このため、本実施の形態のELディスプレイ61では、有機EL素子12を発光制御する直前に駆動電圧とは極性が反対の反対電圧を印加させることができ、より良好に有機EL素子12の寿命を延長することができる。

【0082】なお、本実施の形態のELディスプレイ6

1では、上述のように制御コンデンサ62で発生するスパイクノイズを反対電圧として有機EL素子12に確実に通電するため、同図に示すように、N列の走査線19に順番に印加される走査電圧に所定時間の間隔を設定することが好適である。

【0083】つぎに、本発明の実施の第四の形態を図9および図10を参照して以下に説明する。なお、図9は実施の第二の形態のELディスプレイの要部の回路構造を示す回路図、図10は各部の信号波形を示すタイムチャート、である。

【0084】本実施の形態のELディスプレイ71では、図9に示すように、M行N列の第一の制御TFT20とともに第三から第五の制御TFT72～74が、通電制御手段としてM行N列の有機EL素子12の一組ごとに各々一個ずつ設けられている。

【0085】第三の制御TFT72は、ゲート電極が駆動TFT15と並列に保持コンデンサ16に接続されており、ソース電極が接地線14に接続されており、ドレイン電極が駆動TFT15とは反対の有機EL素子12の一端に接続されている。このため、第三の制御TFT72は駆動TFT15と同様に、電源線3から接地線4に印加される駆動電圧を保持コンデンサ16の保持電圧に対応して有機EL素子12に供給するので、保持コンデンサ16の保持電圧が放電されると、有機EL素子12を電源線13および接地線14から切断する。

【0086】第n列目の第四の制御TFT73は、ゲート電極とソース電極とが第(n-1)列目の走査線19に接続されており、ドレイン電極が有機EL素子12と第三の制御TFT72との接点に接続されている。第n列目の第五の制御TFT74は、ゲート電極が第(n-1)列目の走査線19に接続されており、ソース電極が有機EL素子12と駆動TFT15との接点に接続されており、ドレイン電極が接地線14に接続されている。

【0087】このため、第n列目の第四第五の制御TFT73, 74は、第n列目の走査線19に走査電圧が入力されるとオン状態となり、その走査電圧を駆動電圧とは極性が反対の反対電圧として第n列目の有機EL素子12から接地線14まで通電させる。

【0088】上述のような構成において、本実施の形態のELディスプレイ71では、図10に示すように、第(n-1)列目の走査線19に入力される走査電圧により第n列目の第一の制御TFT20をオン状態として第n列目の保持コンデンサ16の保持電圧を放電させ、これで駆動TFT15と第三の制御TFT72とをオフ状態として第n列目の有機EL素子12を浮遊させる。

【0089】同時に、第(n-1)列目の走査線19に入力される走査電圧により第n列目の第四第五の制御TFT73, 74をオン状態として有機EL素子12の両端を第(n-1)列目の走査線19と接地線14とに接続し、第(n-1)列目の走査線19の走査電圧を駆動電圧

とは極性が反対の反対電圧として有機EL素子12に通電する。

【0090】このため、本実施の形態のELディスプレイ71では、有機EL素子12を発光制御する直前に駆動電圧とは極性が反対の反対電圧を確実に通電させることができ、より良好に有機EL素子12の寿命を延長することができる。特に、走査線19に入力される走査電圧を反対電圧として利用するので、反対電圧を生成するために専用の回路が必要でなく、本実施の形態のELディスプレイ71は、簡単な構造で適正な反対電圧を印加させることができる。

【0091】なお、上記形態のELディスプレイ71の第四の制御TFT73は、第(n-1)列目の走査線19に走査電圧が入力されるときに、この走査電圧を有機EL素子12に供給できれば良いので、図11に一変形例として例示するELディスプレイ82のように、上述の第四の制御TFT73をダイオード素子82に換装することも可能である。

【0092】つぎに、本発明の実施の第五の形態を図12および図13を参照して以下に説明する。なお、図12は実施の第二の形態のELディスプレイの要部の回路構造を示す回路図、図13は各部の信号波形を示すタイムチャート、である。

【0093】本実施の形態のELディスプレイ91では、図12に示すように、通電制御手段である第n列目の第一の制御TFT20のゲート電極が、第(n-2)列目の走査線19に接続されているので、第一の制御TFT20は、第(n-2)列目の走査線19に走査電圧が入力されると保持コンデンサ16の保持電圧を放電する。

【0094】上述のような構成において、本実施の形態のELディスプレイ91では、図13に示すように、第(n-2)列目の走査線19に走査電圧が入力された時点で保持コンデンサ16の保持電圧が放電されて第n列目の有機EL素子12が浮遊される。このような状態で第(n-1)列目の走査線19に走査電圧が入力されると、この走査電圧が反対電圧として有機EL素子12に通電される。

【0095】このため、本実施の形態のELディスプレイ91では、有機EL素子12を発光制御する直前に、有機EL素子12への駆動電圧の印加が確実に停止され、このように駆動電圧の印加が完全に停止された状態で、有機EL素子12に反対電圧が通電される。従って、本実施の形態のELディスプレイ91では、有機EL素子12に反対電圧を確実に通電させることができ、さらに良好に有機EL素子12の寿命を延長することができる。

【0096】

【発明の効果】本発明は以上説明したように構成されているので、以下に記載するような効果を奏する。

【0097】本発明の一の画像表示装置による画像表示

方法では、 $(M \times N)$  個の有機EL素子が M 行 N 列の二次元状に配列されている状態で、これら  $(M \times N)$  個の有機EL素子の発光輝度が個々に設定された  $(M \times N)$  個のデータ電圧が M 行のデータ線の各々に順番に N 個ずつ印加され、これら M 行のデータ線に印加されるデータ電圧に同期して N 列の走査線に走査電圧が順番に入力され、これら N 列の走査線に順番に入力される走査電圧により M 行 N 列のスイッチング手段が一列ずつオン状態とされ、これら M 行 N 列のスイッチング手段のオン状態に対応して M 行のデータ線から印加される  $(M \times N)$  個のデータ電圧を M 行 N 列の電圧保持手段が個々に保持すると、電源電極に常時印加されている駆動電圧を  $(M \times N)$  個の電圧保持手段の保持電圧に個々に対応して M 行 N 列の駆動トランジスタが  $(M \times N)$  個の有機EL素子に印加するので、これで M 行 N 列の有機EL素子が個々に相違する輝度でアクティブ駆動されてドットマトリクスの多階調の画像が表示されるが、第 n 列目の走査線に走査電圧が入力される直前に第 n 列目の M 個の有機EL素子への駆動電圧の印加を通電制御手段が停止させることにより、同一輝度の画像が連続的に表示される場合でも、アクティブ駆動される有機EL素子の通電を画像の表示制御の直前に一瞬だけ停止させるので、有機EL素子の寿命を延長することができる。

【0098】本発明の他の画像表示装置による画像表示方法では、第 n 列目の走査線に走査電圧が入力される直前に通電制御手段が第 n 列目の M 個の有機EL素子に駆動電圧とは極性が反対の反対電圧を印加させることにより、同一輝度の画像が連続的に表示される場合でも、アクティブ駆動される有機EL素子に印加される電圧の極性が画像の表示制御の直前に一瞬だけ反転されるので、有機EL素子の寿命を延長することができる。

【0099】また、上述のような画像表示装置において、第 (n-a) 列目の走査線に走査電圧が入力されると通電制御手段が第 n 列目の有機EL素子への駆動電圧の印加を停止させることにより、第 n 列目の走査線に走査電圧が入力される直前に第 n 列目の M 個の有機EL素子への駆動電圧の印加を停止させることを、所望のタイミングで簡単かつ確実に実行することができる。

【0100】また、第 (n-a) 列目の走査線に走査電圧が入力されると通電制御手段が第 n 列目の有機EL素子に反対電圧を印加させることにより、第 n 列目の走査線に走査電圧が入力される直前に第 n 列目の M 個の有機EL素子に駆動電圧とは極性が反対の反対電圧を印加させることを、所望のタイミングで簡単かつ確実に実行することができる。

【0101】また、第 (n-a) 列目の走査線に走査電圧が入力されると通電制御手段が第 n 列目の有機EL素子への駆動電圧の印加を停止させて反対電圧を印加させることにより、第 n 列目の走査線に走査電圧が入力される直前に第 n 列目の M 個の有機EL素子に駆動電圧とは極

性が反対の反対電圧を印加させることを、所望のタイミングで簡単かつ確実に実行することができる。

【0102】また、第 (n-b) 列目の走査線に走査電圧が入力されると通電制御手段が第 n 列目の有機EL素子への駆動電圧の印加を停止させ、第 (n-a) 列目の走査線に走査電圧が入力されると第 n 列目の有機EL素子に反対電圧を印加させることにより、有機EL素子の駆動電圧の印加を確実に停止させてから、有機EL素子に反対電圧を確実に通電することができる。

【0103】また、第 (n-a) 列目の前記走査線に走査電圧が入力されると通電制御手段が第 n 列目の電圧保持手段の保持電圧を放電させることにより、有機EL素子への駆動電圧の印加を停止させることを、電圧保持手段の動作制御により簡単かつ確実に実行することができる。

【0104】また、第 (n-a) 列目の前記走査線に走査電圧が入力されると通電制御手段が第 n 列目の有機EL素子と電源電極との接続を切断することにより、有機EL素子への駆動電圧の印加の停止を確実に実行することができる。

【0105】また、第 (n-a) 列目の走査線に入力される走査電圧を通電制御手段が反対電圧として第 n 列目の有機EL素子に通電させることにより、有機EL素子に通電させる反対電圧として走査電圧を利用することができるので、適正な反対電圧を簡単な構造で確実に発生させることができる。

【0106】また、第 (n-b) 列目の走査線に走査電圧が入力されると通電制御手段が第 n 列目の電圧保持手段の保持電圧を放電させ、第 (n-a) 列目の走査線に入力される走査電圧を反対電圧として第 n 列目の有機EL素子に通電させることにより、第 (n-b) 列目の走査線の走査電圧により有機EL素子への駆動電圧の印加を停止させることができ、この通電電流が停止された有機EL素子に第 (n-a) 列目の走査線の走査電圧を反対電圧として通電させることができ、駆動電圧が完全に停止した有機EL素子に反対電圧を印加することができる。

【0107】また、第 (n-b) 列目の走査線に走査電圧が入力されると通電制御手段が第 n 列目の有機EL素子と電源電極との接続を切断し、第 (n-a) 列目の走査線に入力される走査電圧を反対電圧として第 n 列目の有機EL素子に通電させることにより、第 (n-b) 列目の走査線の走査電圧により有機EL素子への駆動電圧の印加を停止させることができ、この通電電流が停止された有機EL素子に第 (n-a) 列目の走査線の走査電圧を反対電圧として通電させることができ、駆動電圧が完全に停止した有機EL素子に反対電圧を印加することができる。

【0108】また、第一列目の有機EL素子の通電を最終列である第 N 列目の走査線の走査電圧で制御することにより、一列前の走査線に走査電圧が入力されると通電

制御手段が有機E L素子の通電を制御する構造でも、第一列目の有機E L素子の通電を簡単な構造で適正なタイミングに制御することができる。

【0109】また、第一列目の走査線に並設されたダミー線にダミーの走査電圧が第一列目の走査電圧の直前に入力され、第一列目の有機E L素子の通電はダミー線にダミーの走査電圧が入力されると制御されることにより、一列前の走査線に走査電圧が入力されると通電制御手段が有機E L素子の通電を制御する構造でも、第一列目の有機E L素子の通電を簡単な構造で適正なタイミングに制御することができる。

【0110】また、第一列目の有機E L素子は第(N-1)列目の走査線に走査電圧が入力されると駆動電圧が停止され、第N列目の走査線に走査電圧が入力されると反対電圧が通電され、第二列目の有機E L素子は第N列目の走査線に走査電圧が入力されると駆動電圧が停止されることにより、二列前の走査線に走査電圧が入力されると通電制御手段が有機E L素子に印加される駆動電圧を停止させ、一列前の走査線に走査電圧が入力されると有機E L素子に反対電圧を印加させる構造でも、第一列目および第二列目の有機E L素子の通電を簡単な構造で適正なタイミングに制御することができる。

【0111】また、第一列目の走査線に並設された第一第二のダミー線に第一第二のダミーの走査電圧が第一列目の走査電圧の直前に入力され、第一列目の有機E L素子は第一のダミー線に走査電圧が入力されると駆動電圧が停止され、第二のダミー線に走査電圧が入力されると反対電圧が通電され、第二列目の有機E L素子は第二のダミー線に走査電圧が入力されると駆動電圧が停止されることにより、二列前の走査線に走査電圧が入力されると通電制御手段が有機E L素子に印加される駆動電圧を停止させ、一列前の走査線に走査電圧が入力されると有機E L素子に反対電圧を印加させる構造でも、第一列目および第二列目の有機E L素子の通電を簡単な構造で適正なタイミングに制御することができる。

#### 【図面の簡単な説明】

【図1】本発明の画像表示装置の実施の第一の形態であるE Lディスプレイの要部の回路構造を示す回路図である。

【図2】E Lディスプレイの全体構造を示すブロック図である。

【図3】有機E L素子の部分の薄膜構造を示す断面図である。

【図4】E Lディスプレイの各部の信号波形を示すタイムチャートである。

【図5】実施の第二の形態のE Lディスプレイの要部の回路構造を示す回路図である。

【図6】各部の信号波形を示すタイムチャートである。

【図7】実施の第二の形態のE Lディスプレイの要部の回路構造を示す回路図である。

【図8】各部の信号波形を示すタイムチャートである。

【図9】実施の第二の形態のE Lディスプレイの要部の回路構造を示す回路図である。

【図10】各部の信号波形を示すタイムチャートである。

【図11】一変形例のE Lディスプレイの要部の回路構造を示す回路図である。

【図12】実施の第二の形態のE Lディスプレイの要部の回路構造を示す回路図である。

【図13】各部の信号波形を示すタイムチャートである。

【図14】一従来例のE Lディスプレイの要部を示す回路図である。

【図15】各部の信号波形を示すタイムチャートである。

#### 【符号の説明】

1 1, 5 1, 6 1, 7 1, 8 1, 9 1 E Lディスプレイ

1 2 有機E L素子

1 3 一対の電源電極の一方である電源線

1 4 一対の電源電極の一方である接地線

1 5 駆動トランジスタである駆動TFT

1 6 電圧保持手段である保持コンデンサ

1 7 スイッチング手段であるスイッチングTFT

1 8 データ線

1 9 走査線

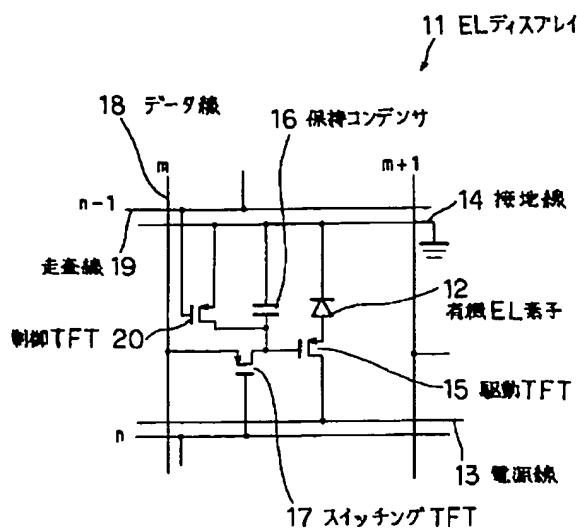
2 0, 5 2, 7 2～7 4 通電制御手段である制御TFT

2 1 ダミー線

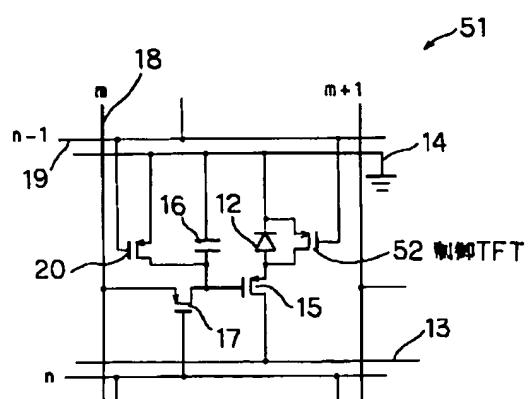
6 2 通電制御手段である制御コンデンサ

8 2 通電制御手段であるダイオード素子

【図1】

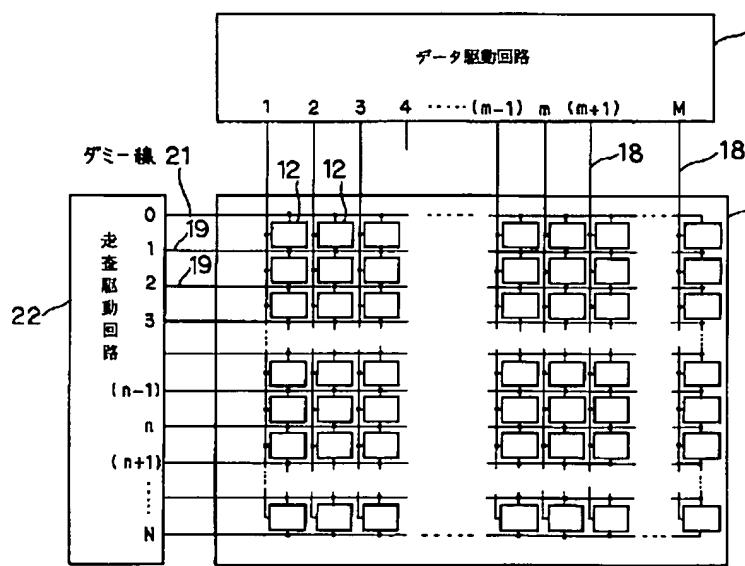


【図5】

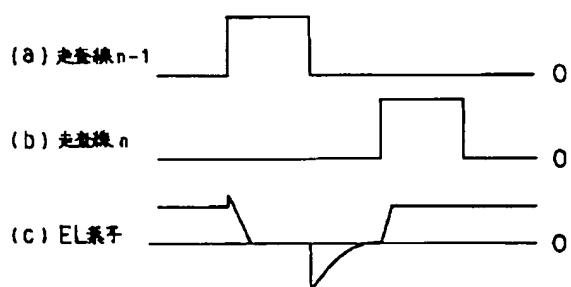


【図9】

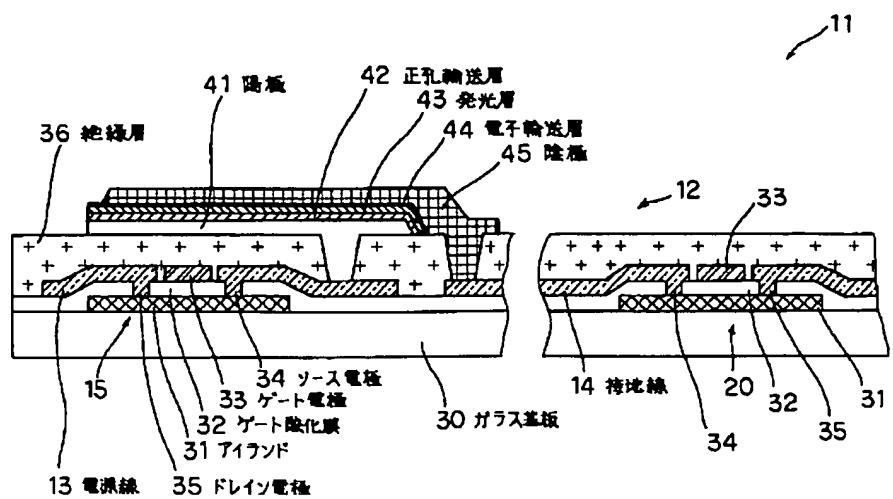
【図2】



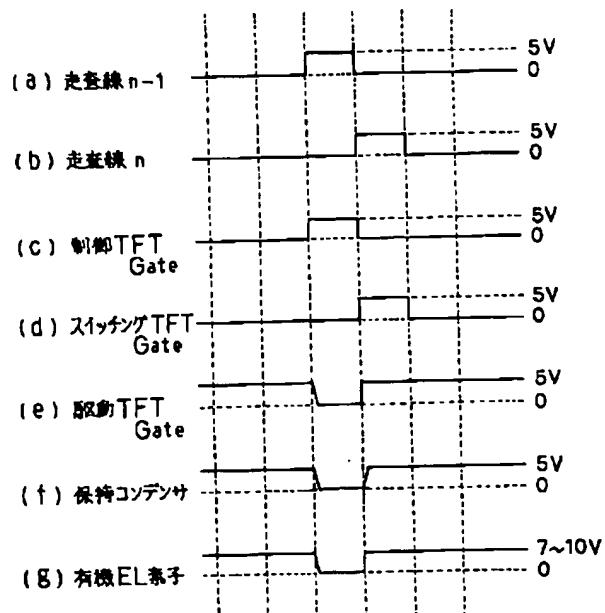
【図8】



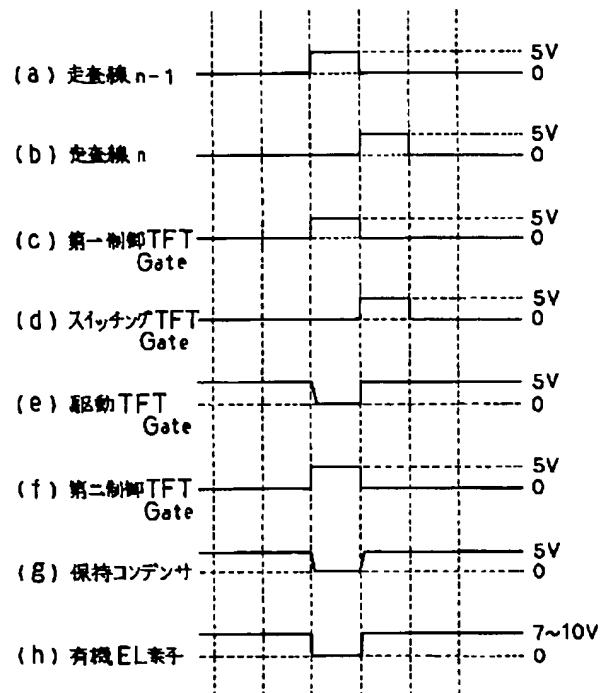
【図3】



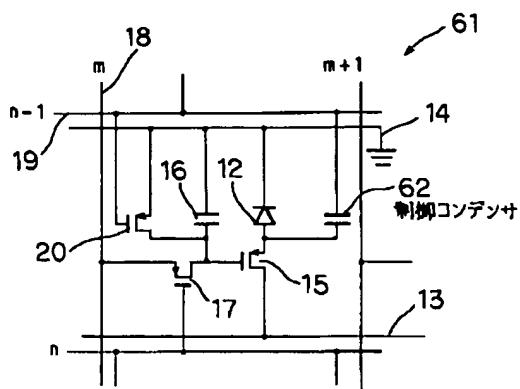
【図4】



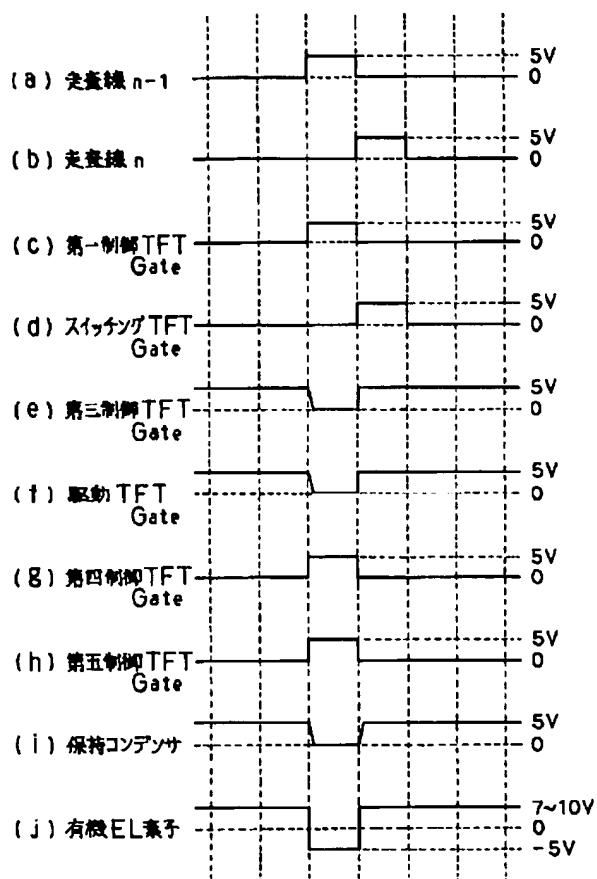
【図6】



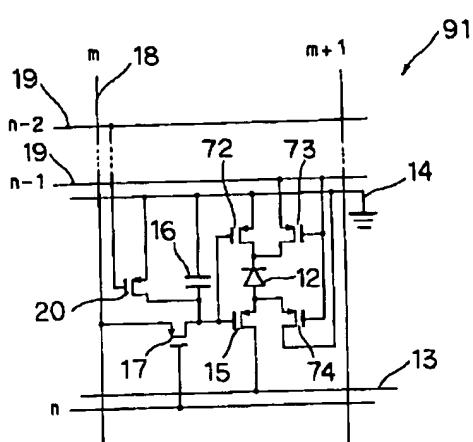
[图7]



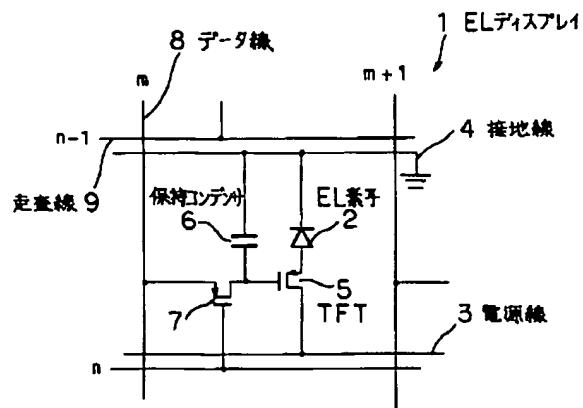
【四 10】



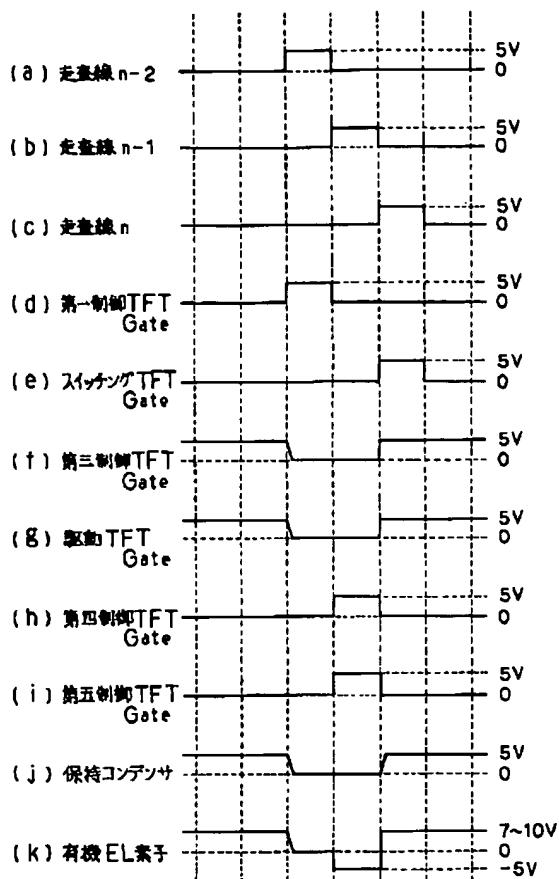
【図12】



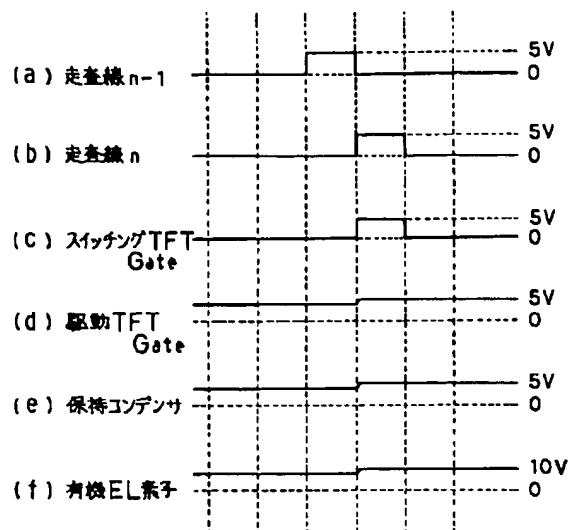
【図14】



【図13】



【図15】



## フロントページの続き

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 EE28 FF11 HH11 JJ02 JJ03  
 JJ04 JJ06  
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[Title of the Invention] METHOD OF AND DEVICE FOR DISPLAYING IMAGE

[Abstract]

[Problem] In a device for displaying an image carrying out active driving of organic EL elements in M columns and N rows, to extend the life of the organic EL elements.

[Means for Resolution] A driving voltage of a power source line 13 is applied to an organic EL element 12 in correspondence with a voltage held by a holding capacitor 16 to carry out light emission control of the organic EL element 12 by active driving, in which, by making the voltage held by the holding capacitor 16 in the n-th row discharged with a timing of a scanning voltage in the (n - 1)-th row to momentarily stop the driving voltage of the organic EL element 12 immediately before lighting control.

[Claims]

[Claim 1] A method of displaying an image for a device for displaying an image, wherein

the device comprises: organic EL (Electro-Luminescence) elements of  $(M \times N)$  in number in a two-dimensional arrangement of M columns and N rows (each of M and N is a specified natural number); data lines in M columns to which data voltages are applied in order, with which luminance of luminescence of each of the above-described  $(M \times N)$  organic EL elements is individually determined; scanning lines in N rows to which scanning voltages are inputted in order in synchronism with the data voltages applied to the data lines in M columns; switching means arranged in M columns and N rows for being brought into a turned ON state row by row by the scanning voltages inputted to the scanning lines in N rows in order; voltage holding means arranged in M columns and N rows for individually holding the data voltages of  $(M \times N)$  in number applied from the data lines in M columns in correspondence with the turned ON states of the switching means in M columns and N rows; a pair of power source electrodes to which a specified driving voltage is always applied; and driving transistors arranged in M columns and N rows applying the driving voltage always applied to the power source electrodes to the organic EL elements of  $(M \times N)$  in number individually in correspondence with the voltages held by the voltage holding

means of  $(M \times N)$  in number, and

the method makes application of the driving voltage to the organic EL elements of  $M$  in number in  $n$  rows to stop immediately before the scanning voltage is inputted to the scanning line in the  $n$ -th row.

[Claim 2] A method of displaying an image for a device for displaying an image, wherein

the device comprises: organic EL elements of  $(M \times N)$  in number in a two-dimensional arrangement of  $M$  columns and  $N$  rows; data lines in  $M$  columns to which data voltages are applied in order, with which luminance of luminescence of each of the above-described  $(M \times N)$  organic EL elements is individually determined; scanning lines in  $N$  rows to which scanning voltages are inputted in order in synchronism with the data voltages applied to the data lines in  $M$  columns; switching means arranged in  $M$  columns and  $N$  rows for being brought into a turned ON state row by row by the scanning voltages inputted to the scanning lines in  $N$  rows in order; voltage holding means arranged in  $M$  columns and  $N$  rows for individually holding the data voltages of  $(M \times N)$  in number applied from the data lines in  $M$  columns in correspondence with the turned ON states of the switching means in  $M$  columns and  $N$  rows; a pair of power source electrodes to which a specified driving voltage is always applied; and driving transistors arranged in  $M$  columns and  $N$  rows applying the driving voltage always applied to the power source electrodes

to the organic EL elements of  $(M \times N)$  in number individually in correspondence with the voltages held by the voltage holding means of  $(M \times N)$  in number, and

the method makes a reverse voltage, with a polarity thereof being reversed to that of the driving voltage, applied to the organic EL elements of  $M$  in number in an  $n$ -th row immediately before the scanning voltage is inputted to the scanning line in the  $n$ -th row.

[Claim 3] A device for displaying an image comprising: organic EL elements of  $(M \times N)$  in number in a two-dimensional arrangement of  $M$  columns and  $N$  rows;

data lines in  $M$  columns to which data voltages are applied in order, with which luminance of luminescence of each of the above-described  $(M \times N)$  organic EL elements is individually determined;

scanning lines in  $N$  rows to which scanning voltages are inputted in order in synchronism with the data voltages applied to the data lines in  $M$  columns;

switching means arranged in  $M$  columns and  $N$  rows for being brought into a turned ON state row by row by the scanning voltages inputted to the scanning lines in  $N$  rows in order;

voltage holding means arranged in  $M$  columns and  $N$  rows for individually holding the data voltages of  $(M \times N)$  in number applied from the data lines in  $M$  columns in correspondence with the turned ON states of the switching means in  $M$  columns and

N rows;

a pair of power source electrodes to which a specified driving voltage is always applied;

driving transistors arranged in M columns and N rows applying the driving voltage always applied to the power source electrodes to the organic EL elements of  $(M \times N)$  in number individually in correspondence with the voltages held by the voltage holding means of  $(M \times N)$  in number; and

energizing controlling means for making application of the driving voltage to the organic EL elements of M in number in an n-th row stop immediately before the scanning voltage is inputted to the scanning line in the n-th row.

[Claim 4] A device for displaying an image comprising:

organic EL elements of  $(M \times N)$  in number in a two-dimensional arrangement of M columns and N rows;

data lines in M columns to which data voltages are applied in order, with which luminance of luminescence of each of the above-described  $(M \times N)$  organic EL elements is individually determined;

scanning lines in N rows to which scanning voltages are inputted in order in synchronism with the data voltages applied to the data lines in M columns;

switching means arranged in M columns and N rows for being brought into a turned ON state row by row by the scanning voltages inputted to the scanning lines in N rows in order;

voltage holding means arranged in M columns and N rows for individually holding the data voltages of  $(M \times N)$  in number applied from the data lines in M columns in correspondence with the turned ON states of the switching means in M columns and N rows;

a pair of power source electrodes to which a specified driving voltage is always applied;

driving transistors arranged in M columns and N rows applying the driving voltage always applied to the power source electrodes to the organic EL elements of  $(M \times N)$  in number individually in correspondence with the voltages held by the voltage holding means of  $(M \times N)$  in number; and

energizing controlling means for making a reverse voltage, with a polarity thereof being reversed to that of the driving voltage, applied to the organic EL elements of M in number in an n-th row immediately before the scanning voltage is inputted to the scanning line in the n-th row.

[Claim 5] The device for displaying an image as claimed in claim 3 wherein the energizing controlling means, on inputting of the scanning voltage to the scanning line in an  $(n - a)$ -th row ( $a$  is a natural number smaller than  $N$ ), makes the application of the driving voltage to the organic EL elements in the n-th row stop.

[Claim 6] The device for displaying an image as claimed in claim 4 wherein the energizing controlling means, on inputting

of the scanning voltage to the scanning line in an (n - a)-th row, makes the reverse voltage applied to the organic EL elements in the n-th row.

[Claim 7] The device for displaying an image as claimed in claim 4 wherein the energizing controlling means, on inputting of the scanning voltage to the scanning line in an (n - a)-th row, makes the application of the driving voltage to the organic EL elements in the n-th row stop and, along with this, makes the reverse voltage applied to the organic EL elements in the n-th row.

[Claim 8] The device for displaying an image as claimed in claim 4 wherein the energizing controlling means, on inputting of the scanning voltage to the scanning line in an (n - b)-th row (b is an integer larger than a and smaller than N), makes the application of the driving voltage to the organic EL elements in the n-th row stop, and on inputting of the scanning voltage to the scanning line in an (n - a)-th row, makes the reverse voltage applied to the organic EL elements in the n-th row.

[Claim 9] The device for displaying an image as claimed in claim 5 wherein the energizing controlling means, on inputting of the scanning voltage to the scanning line in the (n - a)-th row, makes the voltage holding means in the n-th row discharge the voltages held thereby.

[Claim 10] The device for displaying an image as claimed in claim 5 or 9 wherein the energizing controlling means, on

inputting of the scanning voltage to the scanning line in the (n - a) -th row, makes connections between the organic EL elements in the n-th row and the power source electrodes cut off.

[Claim 11] The device for displaying an image as claimed in any one of claims 6 to 8 wherein the energizing controlling means makes the scanning voltage being inputted to the scanning line in the (n - a) -th row energize the organic EL elements in the n-th row as the reverse voltage.

[Claim 12] The device for displaying an image as claimed in claim 8 wherein the energizing controlling means, on inputting of the scanning voltage to the scanning line in the (n - b) -th row, makes the voltage holding means in the n-th row discharge the voltages held thereby, and makes the scanning voltage being inputted to the scanning line in the (n - a) -th row energize the organic EL elements in the n-th row as the reverse voltage.

[Claim 13] The device for displaying an image as claimed in claim 8 wherein the energizing controlling means, on inputting of the scanning voltage to the scanning line in the (n - b) -th row, makes connections between the organic EL elements in the n-th row and the power source electrodes cut off, and makes the scanning voltage inputted to the scanning line in the (n - a) -th row energize the organic EL elements in the n-th row as the reverse voltage.

[Claim 14] The device for displaying an image as claimed in any one of claims 5 to 7 wherein

"a" is given as "a = 1", and  
the energizing controlling means, on inputting of the scanning voltage to the scanning line in the N-th row, controls energizing of the organic EL elements in the first row.

[Claim 15] The device for displaying an image as claimed in any one of claims 5 to 7 wherein

"a" is given as "a = 1", and  
in parallel with the scanning line in the first row, a dummy line is also provided to which a dummy scanning voltage is inputted immediately before the scanning voltage for the first row, and the energizing controlling means, on inputting of the scanning voltage to the dummy line, controls energizing of the organic EL elements in the first row.

[Claim 16] The device for displaying an image as claimed in claim 8 wherein

"a" is given as "a = 1" and "b" is given as "b = 2", and  
the energizing controlling means, on inputting of the scanning voltage to the scanning line in an (N - 1)-th row, makes the application of the driving voltage to the organic EL elements in the first row stop, and on inputting of the scanning voltage to the scanning line in an N-th row, makes the reverse voltage applied to the organic EL elements in the first row, and along with this, makes the application of the driving voltage to the organic EL elements in the second row stop.

[Claim 17] The device for displaying an image as claimed

in claim 8 wherein

"a" is given as "a = 1" and "b" is given as "b = 2", and in parallel with the scanning line in the first row, a first and second dummy lines are also provided to which dummy scanning voltages are inputted in order immediately before the scanning voltage for the first row, and the energizing controlling means, on inputting of the scanning voltage to the first dummy line, makes the application of the driving voltage to the organic EL elements in the first row stop, and on inputting of the scanning voltage to the second dummy line, makes the reverse voltage applied to the organic EL elements in the first row, and along with this, makes the application of the driving voltage to the organic EL elements in the second row stop.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention Belongs]

The present invention relates to a method of and a device for displaying an image by which a number of organic EL elements in a two-dimensional arrangement are subjected to active driving to display an image.

[0002]

[Prior Art]

An EL display is now developed as an image displaying device which displays a dot matrix image with a number of organic EL elements in a two dimensional arrangement. Such an image

displaying device is for displaying various kinds of images in an area such as a passenger room of a vehicle where light and darkness are remarkably changed. The organic EL element is a light emitting element that spontaneously emits light and can be driven by a DC current supplied by a low voltage.

[0003] Driving modes of the organic EL element may be classified into passive and active. With the active mode, the organic EL element is continuously lighted until a displayed image is renewed to allow realization of high luminance with high efficiency. Here, as an example of a conventional image display device, an EL display in which an active driving of the organic EL element is carried out will be explained below with reference to Fig. 14 and Fig. 15. Figure 14 is a circuit diagram showing a principal part of an EL display of an example of a conventional one, and Fig. 15 is a time chart showing signal waveforms of various parts.

[0004] Here, an EL display 1 presented as an example of conventional one is provided with an organic EL element 2, and a power source line 3 and a grounding line 4 as a pair of power source electrode. To the power source line 3, a specified driving voltage is always applied, and the grounding line 4 is always maintained at "0" voltage as a reference voltage.

[0005] The organic EL element 2 is directly connected to the grounding line 4, while, is connected to the power source line 3 through a driving TFT (Thin Film Transistor) 5. The driving

TFT 5 is provided with a gate electrode. A driving voltage applied from the power source line 3 to the grounding line 4 is supplied to the organic EL element 2 in correspondence with a data voltage applied to the gate electrode.

[0006] To the gate electrode of the driving TFT 5, a holding capacitor 6 is connected as voltage holding means with an end thereof. The other end of the holding capacitor 6 is also connected to the grounding line 4. Moreover, to the holding capacitor 6 and the gate electrode of the driving TFT 5, a data line 8 is connected through a switching TFT 7 as switching means. To a gate electrode of the switching TFT 7, a scanning line 9 is connected.

[0007] To the data line 8, there is supplied a data voltage for carrying out driving control of the light emission luminance of the organic EL element 2. To the scanning line 9, there is inputted a scanning voltage for carrying out operation control of the switching TFT 7. The holding capacitor 6 functions to hold the data voltage to apply it to the gate electrode of the driving TFT 5. The switching TFT 7 functions to close and open the connection between the holding capacitor 6 and the data line 8.

[0008] In the EL display 1 shown as an example of conventional one here, the organic EL display elements of (M x N) in number is in a two-dimensional arrangement of M columns and N rows (not shown). To the organic EL elements 2 in M columns and N

rows, the data lines 8 in M columns and the scanning lines 9 in N rows are provided in a matrix connection. Here, a matrix is expressed with a one-dimensional arrangement in parallel with the vertical direction taken as a column and a one-dimensional arrangement in parallel with the horizontal direction taken as a row. This, however, only belongs to a matter of definition, so that the expression may be reversed.

[0009] In the EL display 1 with the above-explained arrangement, driving control of the organic EL elements 2 can be carried out with variable light emission luminance. In this case, as shown as (b) and (c) in Fig. 15, the scanning voltage is inputted to the scanning line 9 to make the operation of the switching TFT 7 controlled in being turned ON. In this state, as shown as (e) in the figure, a data voltage corresponding to the light emission luminance of the organic EL element 2 is supplied from the data line 8 to the holding capacitor 6 to be made held.

[0010] As shown as (d) in the figure, the data voltage held by the holding capacitor 6 is applied to the gate electrode of the driving TFT 5. Thus, as shown as (f) in the figure, the driving voltage always generated across the power source line 3 and the grounding line 4 is to be supplied to the organic EL element 2 by the driving TFT 5 so as to be in correspondence with the gate voltage thereof. Therefore, the organic EL element 2 is to emit light with luminance corresponding to the data

voltage supplied to the data line 8.

[0011] In the EL display 1, the data voltages to the data lines 8 in M columns and the scanning voltages to the scanning lines 9 in the N rows are inputted in a matrix. Therefore, the organic EL elements 2 arranged in M columns and N rows are individually lighted with luminance levels different from one another. This provides a dot matrix image with gradation thereof presented element by element.

[0012] In the case, in the EL display 1, as shown by (a) and (b) in Fig. 15, the scanning voltages are inputted to the scanning lines 9 in N rows row by row in order. Thus, when the scanning voltage is inputted, the data voltages of M in number in a series are to be inputted in order to the data lines 8 in M columns.

[0013] Moreover, as explained above, the state, in which the driving voltage is applied to the organic EL element 2 in correspondence with the data voltage held by the holding capacitor 6, is continued even though the operation of the switching TFT 7 is controlled to be turned OFF by the scanning voltage of the scanning line 9. This makes the organic EL element 2 continue lighting controlled to provide specified luminance until the next control to enable the EL display 1 to display an image with high luminance and high contrast.

[0014]

[Problems that the Invention is to Solve]

In the EL display 1 as described above, the organic EL elements 2 arranged in M columns and N rows are made individually lighted with desired luminance levels to make it possible to display an image with multi-gradation. In particular, application of the driving voltage of the organic EL element 2 controlled at a desired voltage level can be continued until the next control. Therefore, the organic EL element 2 can be made continuously lighted to allow an image to be displayed with high luminance.

[0015] However, the EL display 1 operated by active driving causes short life of the organic EL element 2. Various kinds of reasons are considered, and it becomes clear that the organic EL element 2 characteristically becomes short life with continuous application of driving voltage with the same polarity.

[0016] For example, it is confirmed that, in an EL display with organic EL elements 2 operated by passive driving (not shown), polarity of voltages applied to the organic EL elements 2 is reversed in driving process thereof to provide the organic EL device 2 a longer life compared with the case of active driving. In the EL display with a passive mode, however, the organic EL element is not lighted with high luminance and high efficiency to make it difficult to apply the EL display to a device for which high luminance is desired.

[0017] The invention was made in view of the above-explained problem with an object of providing a method of and a device

for displaying an image which can extend the life of the organic EL element while lighting the element by an active mode driving with high luminance and high efficiency.

[0018]

[Means for Solving the Problem]

A device for displaying an image according to the invention comprises: organic EL elements of  $(M \times N)$  in number in a two-dimensional arrangement of M columns and N rows; data lines in M columns to which data voltages are applied in order, with which luminance of luminescence of each of the above-described  $(M \times N)$  organic EL elements is individually determined; scanning lines in N rows to which scanning voltages are inputted in order in synchronism with the data voltages applied to the data lines in M columns; switching means arranged in M columns and N rows for being brought into a turned ON state row by row by the scanning voltages inputted to the scanning lines in N rows in order; voltage holding means arranged in M columns and N rows for individually holding the data voltages of  $(M \times N)$  in number applied from the data lines in M columns in correspondence with the turned ON states of the switching means in M columns and N rows; a pair of power source electrodes to which a specified driving voltage is always applied; driving transistors arranged in M columns and N rows applying the driving voltage always applied to the power source electrodes to the organic EL elements of  $(M \times N)$  in number individually in correspondence with the

voltages held by the voltage holding means of  $(M \times N)$  in number; and energizing controlling means for making application of the driving voltage to the organic EL elements of  $M$  in number in an  $n$ -th row stop immediately before the scanning voltage is inputted to the scanning line in the  $n$ -th row.

[0019] Therefore, in a method of displaying an image by a device for displaying an image according to the invention, with organic EL elements of  $(M \times N)$  in number being in a two-dimensional arrangement of  $M$  columns and  $N$  rows, data voltages of  $(M \times N)$  in number, with which luminance of light emission of each of the above-described  $(M \times N)$  organic EL elements is individually determined, are applied to each of data lines in  $M$  columns  $N$  by  $N$  in order, and scanning voltages are inputted to scanning lines in  $N$  rows in order in synchronism with the data voltages applied to the data lines in  $M$  columns. By the scanning voltages inputted to the scanning lines in  $N$  rows in order, switching means arranged in  $M$  columns and  $N$  rows are brought into a turned ON state row by row, and in correspondence with the turned ON states of the switching means in  $M$  columns and  $N$  rows, voltage holding means arranged in  $M$  columns and  $N$  rows individually hold the data voltages of  $(M \times N)$  in number applied from the data lines in  $M$  columns. Driving transistors arranged in  $M$  columns and  $N$  rows apply the driving voltage always applied to the power source electrodes to the organic EL elements of  $(M \times N)$  in number individually in correspondence with the

voltages held by the voltage holding means of  $(M \times N)$  in number. This makes the organic EL elements arranged in  $M$  columns and  $N$  rows subjected to active driving with individually different luminance levels to display a dot matrix multi-gradation image. However, the energizing controlling means makes application of the driving voltage to the organic EL elements of  $M$  in number in an  $n$ -th row stop immediately before the scanning voltage is inputted to the scanning line in the  $n$ -th row. Therefore, even in the case when an image with the same luminance is continuously displayed, energizing of each of the organic EL elements subjected to active driving is momentarily stopped immediately before the display control of the image.

[0020] Another device for displaying an image according to the invention comprises: organic EL elements of  $(M \times N)$  in number in a two-dimensional arrangement of  $M$  columns and  $N$  rows; data lines in  $M$  columns to which data voltages are applied in order, with which luminance of luminescence of each of the above-described  $(M \times N)$  organic EL elements is individually determined; scanning lines in  $N$  rows to which scanning voltages are inputted in order in synchronism with the data voltages applied to the data lines in  $M$  columns; switching means arranged in  $M$  columns and  $N$  rows for being brought into a turned ON state row by row by the scanning voltages inputted to the scanning lines in  $N$  rows in order; voltage holding means arranged in  $M$  columns and  $N$  rows for individually holding the data voltages

of  $(M \times N)$  in number applied from the data lines in  $M$  columns in correspondence with the turned ON states of the switching means in  $M$  columns and  $N$  rows; a pair of power source electrodes to which a specified driving voltage is always applied; driving transistors arranged in  $M$  columns and  $N$  rows applying the driving voltage always applied to the power source electrodes to the organic EL elements of  $(M \times N)$  in number individually in correspondence with the voltages held by the voltage holding means of  $(M \times N)$  in number; and energizing controlling means for making a reverse voltage, with a polarity thereof being reversed to that of the driving voltage, applied to the organic EL elements of  $M$  in number in an  $n$ -th row immediately before the scanning voltage is inputted to the scanning line in the  $n$ -th row.

[0021] Therefore, in a method of displaying an image by a device for displaying an image, with organic EL elements of  $(M \times N)$  in number being in a two-dimensional arrangement of  $M$  columns and  $N$  rows, data voltages of  $(M \times N)$  in number, with which luminance of luminescence of each of the above-described  $(M \times N)$  organic EL elements is individually determined, are applied to data lines in  $M$  columns  $N$  by  $N$  in order, and scanning voltages are inputted to scanning lines in  $N$  rows in order in synchronism with the data voltages applied to the data lines in  $M$  columns. By the scanning voltages inputted to the scanning lines in  $N$  rows in order, switching means arranged in  $M$  columns

and N rows are brought into a turned ON state row by row, and in correspondence with the turned ON states of the switching means in M columns and N rows, voltage holding means arranged in M columns and N rows individually hold the data voltages of  $(M \times N)$  in number applied from the data lines in M columns. Driving transistors arranged in M columns and N rows apply the driving voltage always applied to the power source electrodes to the organic EL elements of  $(M \times N)$  in number individually in correspondence with the voltages held by the voltage holding means of  $(M \times N)$  in number. This makes the organic EL elements arranged in M columns and N rows subjected to active driving with individually different luminance levels to display a dot matrix multi-gradation image. However, the energizing controlling means makes a reverse voltage, with a polarity thereof being reversed to that of the driving voltage, applied to the organic EL elements of M in number in an n-th row immediately before the scanning voltage is inputted to the scanning line in the n-th row. Therefore, even in the case when an image with the same luminance is continuously displayed, the polarity of the voltage applied to each of the organic EL elements subjected to active driving is momentarily reversed immediately before the display control of the image.

[0022] In the device for displaying an image as explained above, the energizing controlling means, on inputting of the scanning voltage to the scanning line in an  $(n - a)$ -th row,

can also make the application of the driving voltage to the organic EL elements in the n-th row stop. In this case, on inputting of the scanning voltage to the scanning line in an (n - a)-th row, the energizing controlling means makes the application of the driving voltage to the organic EL elements in the n-th row stop. Therefore, it is simply and reliably carried out with a desired timing that application of the driving voltage to the organic EL elements of M in number in an n-th row is made stopped immediately before the scanning voltage is inputted to the scanning line in the n-th row.

[0023] In the device for displaying an image as explained above, the energizing controlling means, on inputting of the scanning voltage to the scanning line in an (n - a)-th row, can also make the reverse voltage applied to the organic EL elements in the n-th row. In this case, on inputting of the scanning voltage to the scanning line in an (n - a)-th row, the energizing controlling means makes the reverse voltage applied to the organic EL elements in the n-th row. Therefore, it is simply and reliably carried out with a desired timing that a reverse voltage, with a polarity thereof being reversed to that of the driving voltage, is made applied to the organic EL elements of M in number in an n-th row immediately before the scanning voltage is inputted to the scanning line in the n-th row.

[0024] In the device for displaying an image as explained

above, the energizing controlling means, on inputting of the scanning voltage to the scanning line in an  $(n - a)$ -th row, can also make the application of the driving voltage to the organic EL elements in the  $n$ -th row stop and, along with this, make the reverse voltage applied to the organic EL elements in the  $n$ -th row. In this case, on inputting of the scanning voltage to the scanning line in an  $(n - a)$ -th row, the energizing controlling means makes the application of the driving voltage to the organic EL elements in the  $n$ -th row stop and makes the reverse voltage applied thereto. Therefore, it is simply and reliably carried out with a desired timing that a reverse voltage, with a polarity thereof being reversed to that of the driving voltage, is made applied to the organic EL elements of  $M$  in number in an  $n$ -th row immediately before the scanning voltage is inputted to the scanning line in the  $n$ -th row.

[0025] In the device for displaying an image as explained above, the energizing controlling means, on inputting of the scanning voltage to the scanning line in an  $(n - b)$ -th row ( $b$  is an integer larger than  $a$  and smaller than  $N$ ), can also make the application of the driving voltage to the organic EL elements in the  $n$ -th row stop, and on inputting of the scanning voltage to the scanning line in an  $(n - a)$ -th row, make the reverse voltage applied to the organic EL elements in the  $n$ -th row.

[0026] In this case, on inputting of the scanning voltage to the scanning line in an  $(n - b)$ -th row, the energizing controlling

means makes the application of the driving voltage to the organic EL elements in the n-th row stop, and on inputting of the scanning voltage to the scanning line in an (n - a)-th row, makes the reverse voltage applied to the organic EL elements in the n-th row. Therefor, energizing of the organic EL elements with the reverse voltage is not carried out until the application of the driving voltage thereto is reliably made stopped.

[0027] In the device for displaying an image as explained above, the energizing controlling means, on inputting of the scanning voltage to the scanning line in the (n - a)-th row, can also make the voltage holding means in the n-th row discharge the voltages held thereby. In this case, on inputting of the scanning voltage to the scanning line in the (n - a)-th row, the energizing controlling means makes the voltage holding means in the n-th row discharge the voltages held thereby. Therefore, it is realized by the operation control of the energizing controlling means that application of the driving voltage to the organic EL elements is made stopped.

[0028] In the device for displaying an image as explained above, the energizing controlling means, on inputting of the scanning voltage to the scanning line in the (n - a)-th row, can also make connections between the organic EL elements in the n-th row and the power source electrodes cut off. In this case, on inputting of the scanning voltage to the scanning line in the (n - a)-th row, the energizing controlling means makes

connections between the organic EL elements in the n-th row and the power source electrode cutoff. Therefore, it is reliably carried out that application of the driving voltage to the organic EL elements is made stopped.

[0029] In the device for displaying an image as explained above, the energizing controlling means can also make the scanning voltage being inputted to the scanning line in the (n - a)-th row energize the organic EL elements in the n-th row as the reverse voltage. In this case, the energizing controlling means makes the scanning voltage being inputted to the scanning line in the (n - a)-th row energize the organic EL elements in the n-th row as the reverse voltage. Therefore, for the reverse voltage for energizing the organic EL element, the scanning voltage is utilized.

[0030] In the device for displaying an image as explained above, the energizing controlling means, on inputting of the scanning voltage to the scanning line in the (n - b)-th row, can also make the voltage holding means in the n-th row discharge the voltages held thereby, and make the scanning voltage being inputted to the scanning line in the (n - a)-th row energize the organic EL elements in the n-th row as the reverse voltage.

[0031] In this case, on inputting of the scanning voltage to the scanning line in the (n - b)-th row, the energizing controlling means makes the voltage holding means in the n-th row discharge the voltages held thereby, and makes the scanning

voltage being inputted to the scanning line in the  $(n - a)$ -th row energize the organic EL elements in the  $n$ -th row as the reverse voltage. Therefore, by the operation control of the energizing controlling means, application of the driving voltage to the organic EL elements is made stopped and the organic EL elements with energizing current being thus stopped is energized by the scanning voltage as the reverse voltage.

[0032] In the device for displaying an image as explained above, the energizing controlling means, on inputting of the scanning voltage to the scanning line in the  $(n - b)$ -th row, can also make connections between the organic EL elements in the  $n$ -th row and the power source electrodes cut off, and make the scanning voltage inputted to the scanning line in the  $(n - a)$ -th row energize the organic EL elements in the  $n$ -th row as the reverse voltage.

[0033] In this case, on inputting of the scanning voltage to the scanning line in the  $(n - b)$ -th row, the energizing controlling means makes connections between the organic EL elements in the  $n$ -th row and the power source electrodes cut off, and makes the scanning voltage inputted to the scanning line in the  $(n - a)$ -th row energize the organic EL elements in the  $n$ -th row as the reverse voltage. Therefore, by the cutting off of the power source electrodes, application of the driving voltage to the organic EL elements is made stopped and the organic EL elements with energizing current being thus stopped is

energized by the scanning voltage as the reverse voltage.

[0034] In the device for displaying an image as explained above, "a" is given as "a = 1", and the energizing controlling means, on inputting of the scanning voltage to the scanning line in the N-th row, can also control energizing of the organic EL elements in the first row. In this case, since "a" is given as "a = 1", on inputting of the scanning voltage to the scanning line in the row preceding by one, the energizing controlling means carries out control of energizing of the organic EL elements and energizing of the organic EL elements in the first row is controlled on inputting of the scanning voltage to the scanning line in the N-th row of the last row.

[0035] In the device for displaying an image as explained above, "a" is given as "a = 1", and in parallel with the scanning line in the first row, a dummy line is also provided to which a dummy scanning voltage is inputted immediately before the scanning voltage for the first row, and the energizing controlling means, on inputting of the scanning voltage to the dummy line, can also control energizing of the organic EL elements in the first row.

[0036] In this case, since "a" is given as "a = 1", on inputting of the scanning voltage to the scanning line in the row preceding by one, the energizing controlling means carries out control of energizing of the organic EL elements. However, a dummy scanning voltage is inputted to the dummy line provided

in parallel with the scanning line in the first row immediately before the scanning voltage for the first row. Therefore, energizing of the organic EL elements in the first row is controlled on inputting of the dummy scanning voltage to the dummy line.

[0037] In the device for displaying an image as explained above, "a" is given as "a = 1" and "b" is given as "b = 2", and the energizing controlling means, on inputting of the scanning voltage to the scanning line in an  $(N - 1)$ -th row, can also make the application of the driving voltage to the organic EL elements in the first row stop, and on inputting of the scanning voltage to the scanning line in an  $N$ -th row, make the reverse voltage applied to the organic EL elements in the first row, and along with this, make the application of the driving voltage to the organic EL elements in the second row stop.

[0038] In this case, since "a" is given as "a = 1" and "b" is given as "b = 2", on inputting of the scanning voltage to the scanning line in the row preceding by two, the energizing controlling means makes the application of the driving voltage to the organic EL elements stop, and on inputting of the scanning voltage to the scanning line in the row preceding by one, makes the reverse voltage applied to the organic EL elements. However, the organic EL elements in the first row, on inputting of the scanning voltage to the scanning line in the  $(N - 1)$ -th row, have the application of the driving voltage thereto stopped, and on inputting of the scanning voltage to the scanning line

in the N-th row, are energized by the reverse voltage. The organic EL elements in the second row, on inputting of the scanning voltage to the scanning line in an N-th row, have the application of the driving voltage thereto stopped.

[0039] In the device for displaying an image as explained above, "a" is given as "a = 1" and "b" is given as "b = 2", and in parallel with the scanning line in the first row, a first and second dummy lines are also provided to which dummy scanning voltages are inputted in order immediately before the scanning voltage for the first row, and the energizing controlling means, on inputting of the scanning voltage to the first dummy line, can also make the application of the driving voltage to the organic EL elements in the first row stop, and on inputting of the scanning voltage to the second dummy line, make the reverse voltage applied to the organic EL elements in the first row, and along with this, make the application of the driving voltage to the organic EL elements in the second row stop.

[0040] In this case, since "a" is given as "a = 1" and "b" is given as "b = 2", on inputting of the scanning voltage to the scanning line in the row preceding by two, the energizing controlling means makes the application of the driving voltage to the organic EL elements stop, and on inputting of the scanning voltage to the scanning line in the row preceding by one, makes the reverse voltage applied to the organic EL elements. However, to the first and second dummy lines provided in parallel with

the scanning line in the first row, the first and second dummy scanning voltages are inputted immediately before the scanning voltage for the first row. Therefore, the organic EL elements in the first row, on inputting of the scanning voltage to the first dummy line, have the application of the driving voltage thereto made stopped, and on inputting of the scanning voltage to the second dummy line, are energized by the reverse voltage. The organic EL elements in the second row, on inputting of the scanning voltage to the second dummy line, have the application of the driving voltage thereto made stopped.

[0041] Incidentally, it is necessary for various means referred to in the invention only to be formed so as to realize functions thereof. For example, specialized hardware, computers with proper functions provided by programs, functions realized within computers by proper programs, and combinations thereof are allowed to be such means.

[0042]

[Mode for Carrying Out the Invention]

A first mode for carrying out the invention will be explained in the following with reference to Fig. 1 to Fig. 4. However, about the mode, same parts as those in the example of the conventional device previously explained will be referred to with the same names and detailed explanation thereof will be omitted. Here, a matrix is also expressed with a one-dimensional arrangement in parallel with the vertical direction taken as

a column and a one-dimensional arrangement in parallel with the horizontal direction taken as a row. The definition, however, is for convenience in simplifying explanation, so that reversed naming will not be rejected.

[0043] Figure 1 is a circuit diagram showing a circuit arrangement of a principal part of an EL display as a first carrying out mode of the device for displaying an image according to the invention, Fig. 2 is a block diagram showing an entire arrangement of the EL display, Fig. 3 is a cross sectional view showing a thin film structure of an organic EL element part, and Fig. 4 is a time chart showing signal waveforms of various parts in the EL display.

[0044] As shown in Fig. 1, like one example of the conventional EL display 1, an EL display 11 as a carrying out mode is also provided with an organic EL elements 12 of (M x N) in number. As shown in Fig. 2, the organic EL elements 12 of (M x N) in number are in a two-dimensional arrangement of M columns and N rows.

[0045] Incidentally, the EL display 11 as the carrying out mode is in compliance with the so-called VGA (Video Graphics Array) standard to output a colored image display in an RGB (Red, Green, Blue) system, in which the organic EL elements of (480 x 1980) in number are arranged in 480 columns and 1980 rows.

[0046] The EL display 11 as the carrying out mode also

has a power source line 13 and a grounding line 14 as a pair of power source electrodes. The organic EL element 12 is directly connected to the grounding line 14, and is connected to the power source line 13 through a driving TFT 15 as a driving transistor.

[0047] To a gate electrode of the driving TFT 15, a holding capacitor 16 is connected as voltage holding means. The holding capacitor 16 is also connected to the grounding line 14. To the holding capacitor 16 and the gate electrode of the driving TFT 15, there is connected a drain electrode of a switching TFT 17 as switching means. The switching TFT 17 has a source electrode to which a data line 18 is connected and a gate electrode to which a scanning line 19 is connected.

[0048] The EL display 11 as the carrying out mode, however, unlike the EL display 1 as an example of the conventional one, has controlling TFTs 20 in M columns and N rows each being provided for each of the organic EL elements 12 in M columns and N rows. The controlling TFT 20 is provided as energizing controlling means for making application of a driving voltage to the organic EL elements 12 of M in number in an n-th row stop immediately before a scanning voltage with a rectangular pulse of "5.0 (V)" is inputted to the scanning line 19 in the n-th row.

[0049] The controlling TFT 20 has a drain electrode connected to an interconnection of the holding capacitor 16 and the driving TFT 15, and a source electrode connected to

the grounding line 14. However, the gate electrodes of the controlling TFTs 20 of M in number in the n-th row are connected to the scanning line 19 in an (n - 1)-th row. Thus, the scanning voltage inputted to the scanning line 19 in the (n - 1)-th row makes the holding capacitor 16 in the n-th row discharge a voltage of "5.0 to 0.0 (V)" held thereby.

[0050] However, for the controlling TFTs 20 in the first row to which "n" becomes as "n = 1", there is no presence of the scanning line in the (n - 1)-th row. Thus, in the EL display 11 as the carrying out mode, as shown in Fig. 2, a dummy line 21 is provided in parallel with the scanning line in the first row. To the dummy line 21, there are connected gate electrodes of the controlling TFTs 20 of M in number in the first row.

[0051] Moreover, the scanning lines 19 in N rows and the dummy line 21 in one row are connected to one scanning driving circuit 22. The scanning driving circuit 22 inputs the scanning voltages of (N + 1) in number to the dummy line 21 in one row and the scanning lines 19 in N rows in order for each display of one image. Thus, a dummy scanning voltage is inputted to the dummy line 21 immediately before a scanning voltage is inputted to the scanning line 19 in the first row.

[0052] The data lines 18 in M columns are connected to one data driving circuit 23. The data driving circuit 23 applies data voltages of "5.0 to 0.0 (V)" of (M x N) in number to each of the data lines 18 in M columns in order in synchronism with

each of the scanning voltages of N in number for each display of one image. Therefore, the data voltages of M in number are held by the holding capacitors of M in number in order for each one row.

[0053] Also in the EL display 11 as the carrying out mode, as shown in Fig. 2 and Fig. 3, each of the parts such as the above-explained organic EL elements 12 is formed in a laminated structure on one face of one glass substrate 30. In more detail, as shown in Fig. 3, the driving TFT 15 and the controlling TFT 20 are formed on an island 31 of p-Si layered on the face of the glass substrate 30. On the island 31, a gate oxide film 32 is layered.

[0054] In a middle portion of the gate oxide film 32, there is layered a gate electrode 33 of a metal such as aluminum onto both sides of which there are connected a source electrode 34 and a drain electrode 35, respectively. The electrodes 34 and 35 are formed integrally with the power source line 13 and the grounding line 14. The above explained structure is uniformly sealed by an insulating layer 36.

[0055] The organic EL element 12 is formed on an upper face of the insulating layer 36, on which an anode 41 of ITO (Indium Tin Oxide) is layered. On the anode 41, a hole transporting layer 42, a light emitting layer 43, an electron transporting layer 44, and a cathode 45 of a metal are laminated in the order, with which the organic EL element 12 is formed.

[0056] The insulating layer 36 as explained above has contact holes formed at key points. By the contact holes, the anode 41 of the organic EL element 12 and the source electrode 34 of the driving TFTs 15 are connected, and a cathode 45 and the grounding line 14 are connected.

[0057] The EL display 11 as the carrying out mode is a display in which, to the organic EL elements 12 in M columns and N rows, various kinds of the lines 13, 14, ..., various kinds of the elements 15, 16, ..., and various kinds of the circuits 22, 23, ... are connected to display images in correspondence with image data externally inputted. The organic EL elements 12, each being formed with layers such as a light emitting layer 43 as shown in Fig. 3, are formed in a shape in correspondence with a picture element region of M columns and N rows in the EL display 11.

[0058] In the arrangement as described above, the EL display 11 as the carrying out mode, like one example of the conventional EL display 1, can also make the organic EL elements 12 in M columns and N rows individually emit light with desired luminance levels to display a dot matrix image with multi-gradation element by element. In particular, each of the organic EL elements individually subjected to active driving can realize high luminance with high efficiency.

[0059] In this case, as shown in Fig. 4, with the scanning voltages inputted to the scanning lines 19 in N rows in order,

the switching TFTs 17 in M columns and N rows are brought into a turned ON state row by row in order. Thus, data voltages corresponding to the light emission luminance levels of the organic EL elements 12 of M in number in the one row are individually applied to the data lines 18 in M columns.

[0060] Then, the data voltages of M in number are individually held by the holding capacitor 16 in the one row. The voltages held by the holding capacitors 16 are individually applied to the gate electrodes of the driving TFTs 15 of M in number in the one row. Thus, the driving voltage always applied to the power source line 13 is supplied to the organic EL elements 12 of M in number in the one row.

[0061] The amount of the current corresponds to the voltage applied from the holding capacitor 16 to the gate electrode of the driving TFTs 15. Hence, each of the organic EL elements 12 of M in number in the one row is to be made to emit light with a luminance level corresponding to a controlling current supplied to the data line 18. The state of the operation is maintained by the voltages held by the holding capacitors 16 even though the scanning voltages have been brought to turned OFF states.

[0062] The operation as explained above is carried out for each of the scanning lines in N rows in order. Therefore, the EL display 11 as the carrying out mode can make the organic EL elements 12 in M columns and N rows individually emit light

with desired luminance levels to display a dot matrix image with gradation thereof presented element by element. In addition, the state of light emission of the organic EL element 12 is maintained by the voltage held by the holding capacitor 16 until next light emission control to realize high luminance with high efficiency.

[0063] However, in the EL display 11 as the carrying out mode, although the organic EL elements 12 are subjected to the active driving, energizing of each of the organic EL elements 12 is momentarily stopped immediately before the light emission control. Namely, when the scanning voltage is inputted to the scanning line 19 in the (n - 1)-th row, the controlling TFT 20 in the n-th row is brought into a turned ON state, connecting both ends of the holding capacitor 16 to the grounding line 14 to make energizing of the organic EL element 12 in the n-th row stop.

[0064] Therefore, in the EL display 11 as the carrying out mode, although the state of light emission of the organic EL element 12 is maintained until next light emission control by the active driving, energizing of the organic EL element 12 is momentarily stopped immediately before the light emission control. Hence, the life of the organic EL element 12 subjected to the active driving can be extended.

[0065] In particular, the momentary stopping of the energizing of the organic EL element 12 is controlled by the

scanning voltage of the scanning line 19 in the row preceding by one. Thus, the energizing of the organic EL element 12 can be reliably controlled with the optimum timing. In addition, before the scanning line 19 in the first row, the dummy line 21 is provided in parallel therewith and the dummy scanning voltage inputted to the dummy line 21 makes energizing of the organic EL element 12 stop to allow energizing of all of the organic EL elements 12 in M columns and N rows to be reliably controlled with the optimum timing.

[0066] The invention is not limited to the above mode to allow various modification therefrom within a range without departing from the gist of the invention. For example, in the above mode, an example was presented in which energizing of the organic EL elements 12 in the n-th row is made to be momentarily stopped with the timing of the scanning voltage to the scanning line 19 in the (n - 1)-th row. This can be carried out with the timing of the scanning voltage to the scanning line 19 in the (n - a)-th row. However, "a" taken as 2 or more necessitates the number of the dummy line 21 to be increased, which results in an increase in time for turning OFF the organic EL elements 12 to reduce total luminance. Therefore, it is generally best to take "a" as "a = 1".

[0067] Moreover, in the above mode, an example was presented in which the dummy line 21 is provided in parallel with the scanning line 19 in the first row to input the dummy scanning

voltage. However, it may be also possible to connect the scanning line 19 in the N-th row of the last row to the controlling TFT 20 in the first row to make energizing of the organic EL element 12 in the first row momentarily stop by the scanning voltages inputted to the scanning line 19 in the N-th row.

[0068] In the arrangement of adding the dummy line 21, it is necessary to add the dummy line 21 and an internal circuit of the scanning driving circuit 22. However, there is no necessity for providing sophisticated routing of interconnection. In an arrangement for connecting the scanning line 19 in the N-th row to the controlling TFT 20 in the first row, although there is a possibility of making the routing of interconnection sophisticated, no addition of the dummy line 21 and the internal circuit of the scanning driving circuit 22 is necessary. That is, since the above arrangements have mutually merits and demerits, when the device is put into practice, the best-suited one is well selected by considering various conditions.

[0069] Furthermore, in the above mode, there was shown an example for controlling energizing of the organic EL elements 12 in M columns and N rows with the controlling TFT 20 also arranged in M columns and N rows. It is, however, necessary only that the controlling TFTs 20 can control the organic EL elements 12 of M in number in one row for each scanning voltage. Thus, it is possible to connect, for example, each one of the controlling TFTs 20 of N in number to each one of the scanning

lines 19 in N rows and the organic EL elements 12 of M in number in one row.

[0070] In the arrangement in which the controlling TFTs 20 are disposed also in M columns and N rows, despite an increase in a scale of the circuit, no sophisticated routing of interconnection is necessary. While, in the arrangement in which the controlling TFTs 20 are disposed only in N rows, although there is a possibility of causing sophisticated interconnection, a scale of the circuit can be reduced. Therefore, also in this case, the best-suited one will be practically well suitably selected.

[0071] Incidentally, in actually producing the EL display 11, thin film circuits each having the same pattern are formed in M columns and N rows. This facilitates production of the controlling TFTs 20 also arranged in M columns and N rows. While, in the arrangement in which the controlling TFTs 20 are disposed only in N rows, the controlling TFTs 20 are well suitably formed separately with positions thereof taken at an end of each row on the outside of the picture element region.

[0072] Next, a second mode for carrying out the invention will be explained in the following with reference to Fig. 5 and Fig. 6. However, in the carrying out modes hereafter, same parts as those in previous modes will be referred to with the same names and signs, and detailed explanation thereof will be omitted. Figure 5 is a circuit diagram showing a circuit

arrangement of a principal part of an EL display as the second mode, and Fig. 6 is a time chart showing signal waveforms of various parts.

[0073] In the EL display 51 as the carrying out mode, as shown in Fig. 5, as energizing controlling means for making application of a driving voltage to the organic EL elements 12 of M in number in an n-th row stop immediately before a scanning voltage is inputted to the scanning line 19 in the n-th row, there are provided first controlling TFTs 20 in M columns and N rows, and along with this, second controlling TFTs 52 in M columns and N rows, each being provided for each of the organic EL elements 12 in M columns and N rows.

[0074] The second controlling TFT 52 in the n-th row is connected to the scanning line 19 in the (n - 1)-th row with a gate electrode and connected to both ends of the organic EL element 12 with the both ends thereof. Moreover, the second controlling TFT 52, in the first row, is also connected to the dummy line 21 with the gate electrode.

[0075] In the arrangement as described above, in the EL display 51 as the carrying out mode, like in the EL display 11 previously explained as the first mode, energizing of the organic EL elements 12, subjected to the active driving, is also momentarily stopped immediately before the light emission control. In this case, as shown in Fig. 6, by the scanning voltage inputted to the scanning line 19 in the (n - 1)-th row, both

of the first and second controlling TFTs 20 and 52 in the n-th row are brought into a turned ON state to connect both ends of the holding capacitor 16 to the grounding line 14. Along with this, both ends of the organic EL element 12 in the n-th row are made short-circuited.

[0076] This, in the EL display 51 as the carrying out mode, makes it possible to momentarily stop energizing of the organic EL elements 12 more reliably to allow the life of the organic EL element 12 subjected to active driving to be better extended. In addition, the above-explained second controlling TFT 52 can be also provided only in N rows rather than in M columns and N rows.

[0077] Following this, a third mode for carrying out the invention will be explained in the following with reference to Fig. 7 and Fig. 8. Figure 7 is a circuit diagram showing a circuit arrangement of a principal part of an EL display as the second mode, and Fig. 8 is a time chart showing signal waveforms of various parts.

[0078] In the EL display 61 as the carrying out mode, as shown in Fig. 7, together with the first controlling TFTs 20 in M columns and N rows, there are controlling capacitors 62 as energizing controlling means each one being provided for each one of the organic EL elements 12 in M columns and N rows.

[0079] The controlling capacitor 62 in the n-th row is connected to the scanning line 19 in the (n - 1)-th row with

one end and connected to a connection point of the organic EL element 12 and the driving TFT 15 with the other end. Moreover, the controlling capacitor 62, in the first row, is also connected to the dummy line 21 with the one end.

[0080] In the arrangement as described above, in the EL display 61 as the carrying out mode, as shown in Fig. 6, by the scanning voltage inputted to the scanning line 19 in the  $(n - 1)$ -th row, the controlling TFT 20 in the  $n$ -th row is brought into a turned ON state. Along with this, the scanning voltage is applied to the one end of the controlling capacitor 62.

[0081] Then, as shown in Fig. 8, at the other end of the controlling capacitor 62, there is generated a spike noise with reverse polarity, which is applied to the organic EL element 12 to energize it as a reverse voltage with the polarity reversed to that of the driving voltage. Therefore, in the EL display 61 as the carrying out mode, a reverse voltage, with a polarity thereof being reversed to that of the driving voltage, can be made applied immediately before the light emission control. Hence, the life of the organic EL element 12 can be better extended.

[0082] In the EL display 61 as the carrying out mode, in order to apply the spike noise generated at the controlling capacitor 62 as the reverse voltage to reliably energize the organic EL element 12, as shown in the figure, it is suitable to pose intervals with a specified time in the scanning voltage applied in order to the scanning lines in  $N$  rows.

[0083] In the next, a fourth mode for carrying out the invention will be explained in the following with reference to Fig. 9 and Fig. 10. Figure 9 is a circuit diagram showing a circuit arrangement of a principal part of an EL display as the second mode, and Fig. 10 is a time chart showing signal waveforms of various parts.

[0084] In the EL display 71 as the carrying out mode, as shown in Fig. 9, together with the first controlling TFTs 20 in M columns and N rows, there are provided third to fifth controlling TFTs 72 to 74 as energizing controlling means for each of the organic EL elements 12 in M columns and N rows.

[0085] The third controlling TFT 72 is connected to the holding capacitor 16 with the gate electrode in parallel with the driving TFT 15, connected to the grounding line 14 with the source electrode thereof, and connected to one end of the organic EL element 12 opposite to the driving TFT 15 with the drain electrode thereof. Therefore, the third controlling TFT 72, like the driving TFT 15, supplies the driving voltage, applied from the power source line 3 to the ground line 4, to the organic EL element 12 in correspondence with the voltage held by the holding capacitor 16. Thus, discharge of the voltage held by the holding capacitor 16 brings the organic EL element 12 to be cut off from the power source line 13 and the grounding line 14.

[0086] The fourth controlling TFT 73 in the n-th row is

connected to the scanning line 19 in the  $(n - 1)$ -th row with the gate electrode and the source electrode, and connected to a connection point of the organic EL element 12 and the third controlling TFT 72 with the drain electrode. The fifth controlling TFT 74 in the  $n$ -th row is connected to the scanning line 19 in the  $(n - 1)$ -th row with the gate electrode, connected to the connection point of the organic EL element 12 and the driving TFT 15 with the source electrode, and connected to the grounding line 14 with the drain electrode.

[0087] Therefore, the fourth and fifth controlling TFTs 73 and 74 in the  $n$ -th row are brought into a turned ON state on inputting of the scanning voltage to the scanning line 19 in the  $n$ -th row, and apply the scanning voltage as a reverse voltage, with a polarity thereof being reversed to that of the driving voltage, from the organic EL element 12 to the grounding line 14.

[0088] In the arrangement as described above, in the EL display 71 as the carrying out mode, as shown in Fig. 10, by the scanning voltage inputted to the scanning line 19 in the  $(n - 1)$ -th row, the first controlling TFT 20 in the  $n$ -th row is brought into a turned ON state to discharge the voltage held by the holding capacitor 16 in the  $n$ -th row. This brings the driving TFT 15 and the third controlling TFT 72 into a turned OFF state to make the organic EL element 12 in the  $n$ -th row float.

[0089] At the same time, by the scanning voltage inputted to the scanning line 19 in the (n - 1)-th row, the fourth and fifth controlling TFTs 73 and 74 in the n-th row are brought into a turned ON state to connect both ends of the organic EL element 12 to the scanning line 19 in the (n - 1)-th row and the grounding line 14, respectively. This makes the scanning voltage in the scanning line 19 in the (n - 1)-th row applied to the organic EL element 12 as a reverse voltage with a polarity thereof being reversed to that of the driving voltage.

[0090] Therefore, in the EL display 71 as the carrying out mode, the reverse voltage, with a polarity thereof being reversed to that of the driving voltage, can be made applied immediately before the light emission control. Hence, the life of the organic EL element 12 can be better extended. In particular, utilization of the scanning voltage, inputted to the scanning line 19, as the reverse voltage necessitates no special circuit for producing the reverse voltage, which allows the EL display 71 as the carrying out mode to apply a proper reverse voltage with a simple structure.

[0091] It is necessary only that the fourth controlling TFT 73 in the EL display 71 according to the above mode, when the scanning voltage is inputted to the scanning line 19 in the (n - 1)-th row, can supply the scanning voltage to the organic EL element 12. Therefore, as in an EL display 82 shown in Fig. 11 as an example of variation, the fourth controlling TFT 73

can be further substituted by a diode element 82.

[0092] Subsequent to this, a fifth mode for carrying out the invention will be explained in the following with reference to Fig. 12 and Fig. 13. Figure 12 is a circuit diagram showing a circuit arrangement of a principal part of an EL display as the second mode, and Fig. 13 is a time chart showing signal waveforms of various parts.

[0093] In the EL display 91 as the carrying out mode, as shown in Fig. 12, a gate electrode of a first controlling TFT 20 in the n-th row is connected to a scanning line 19 in the (n - 2)-th row. Thus, the first controlling TFT 20, on inputting of the scanning voltage to the scanning line 19 in the (n - 2)-th row, makes the holding capacitor 16 discharge the voltage held thereby.

[0094] In the arrangement as described above, in the EL display 91 as the carrying out mode, as shown in Fig. 13, at the time when the scanning voltage is inputted to the scanning line 19 in the (n - 2)-th row, the voltage held by the holding capacitor 16 is discharged to make the organic EL element 12 in the n-th row float. In such a state, on inputting of the scanning voltage to the scanning line 19 in the (n - 2)-th row, the scanning voltage energizes the organic EL element 12 as the reverse voltage.

[0095] Therefore, in the EL display 91 as the carrying out mode, application of the driving voltage to the organic

EL element 12 is reliably stopped immediately before the light emission control. With the application of the driving voltage being thus completely stopped, the organic EL element 12 is energized by the reverse voltage. Therefore, in the EL display 91 as the carrying out mode, the organic EL element 12 can be reliably energized by the reverse voltage. Hence, the life of the organic EL element 12 can be better extended.

[0096]

[Advantage of the Invention]

The invention arranged as described above exhibits advantages as described in the following.

[0097] In the method of displaying an image by a device for displaying an image according to the invention, with the organic EL elements of  $(M \times N)$  in number being in a two-dimensional arrangement of  $M$  columns and  $N$  rows, the data voltages of  $(M \times N)$  in number, with which luminance of light emission of each of the above-described  $(M \times N)$  organic EL elements is individually determined, are applied to each of the data lines in  $M$  columns  $N$  by  $N$  in order, and the scanning voltages are inputted to the scanning lines in  $N$  rows in order in synchronism with the data voltages applied to the data lines in  $M$  columns. By the scanning voltages inputted to the scanning lines in  $N$  rows in order, the switching means arranged in  $M$  columns and  $N$  rows are brought into a turned ON state row by row, and in correspondence with the turned ON states of the switching means in  $M$  columns and

N rows, the voltage holding means arranged in M columns and N rows individually hold the data voltages of  $(M \times N)$  in number applied from the data lines in M columns. Then, the driving transistors arranged in M columns and N rows apply the driving voltage always applied to the power source electrodes to the organic EL elements of  $(M \times N)$  in number individually in correspondence with the voltages held by the voltage holding means of  $(M \times N)$  in number. This makes the organic EL elements arranged in M columns and N rows subjected to active driving with individually different luminance levels to display the dot matrix multi-gradation image. However, the energizing controlling means makes application of the driving voltage to the organic EL elements of M in number in an n-th row stop immediately before the scanning voltage is inputted to the scanning line in the n-th row. This makes, even in the case when an image with the same luminance is continuously displayed, energizing of each of the organic EL elements subjected to active driving momentarily stop immediately before the display control of the image. Therefore, the life of the organic EL element can be made extended.

[0098] In the method of displaying an image by another device for displaying an image according to the invention, the energizing controlling means makes a reverse voltage, with a polarity thereof being reversed to that of the driving voltage, applied to the organic EL elements of M in number in the n-th

row immediately before the scanning voltage is inputted to the scanning line in the n-th row. Therefore, even in the case when an image with the same luminance is continuously displayed, the polarity of the voltage applied to each of the organic EL elements subjected to active driving is momentarily reversed immediately before the display control of the image. Thus, the life of the organic EL element can be made extended.

[0099] In the device for displaying an image as explained above, on inputting of the scanning voltage to the scanning line in the (n - a)-th row, the energizing controlling means makes the application of the driving voltage to the organic EL elements in the n-th row stop. Because of this, it can be simply and reliably carried out with a desired timing that the application of the driving voltage to the organic EL elements of M in number in an n-th row is made stopped immediately before the scanning voltage is inputted to the scanning line in the n-th row.

[0100] Moreover, on inputting of the scanning voltage to the scanning line in the (n - a)-th row, the energizing controlling means makes the reverse voltage applied to the organic EL elements in the n-th row. Because of this, it is simply and reliably carried out with a desired timing that a reverse voltage, with a polarity thereof being reversed to that of the driving voltage, is made applied to the organic EL elements of M in number in an n-th row immediately before the scanning voltage is inputted

to the scanning line in the n-th row.

[0101] In addition, the energizing controlling means, on inputting of the scanning voltage to the scanning line in the (n - a)-th row, makes the application of the driving voltage to the organic EL elements in the n-th row stop and makes the reverse voltage applied thereto. Because of this, it is simply and reliably carried out with a desired timing that a reverse voltage, with a polarity thereof being reversed to that of the driving voltage, is made applied to the organic EL elements of M in number in an n-th row immediately before the scanning voltage is inputted to the scanning line in the n-th row.

[0102] Furthermore, on inputting of the scanning voltage to the scanning line in the (n - b)-th row, the energizing controlling means makes the application of the driving voltage to the organic EL elements in the n-th row stop, and on inputting of the scanning voltage to the scanning line in the (n - a)-th row, makes the reverse voltage applied to the organic EL elements in the n-th row. Because of this, energizing of the organic EL elements with the reverse voltage can not be reliably carried out until the application of the driving voltage thereto is reliably made stopped.

[0103] Moreover, the energizing controlling means, on inputting of the scanning voltage to the scanning line in the (n - a)-th row, makes the voltage holding means in the n-th row discharge the voltages held thereby. Because of this, it

is simply and reliably carried out by the operation control of the energizing controlling means that application of the driving voltage to the organic EL elements is made stopped.

[0104] Further, the energizing controlling means, on inputting of the scanning voltage to the scanning line in the (n - a) -th row, makes connections between the organic EL elements in the n-th row and the power source electrodes cut off. Because of this, it is reliably carried out that application of the driving voltage to the organic EL elements is made stopped.

[0105] In addition, the energizing controlling means makes the scanning voltage being inputted to the scanning line in the (n - a) -th row energize the organic EL elements in the n-th row as the reverse voltage. Because of this, the scanning voltage can be utilized as the reverse voltage for energizing the organic EL element to make it possible to reliably generate an adequate reverse voltage with a simple structure.

[0106] Moreover, on inputting of the scanning voltage to the scanning line in the (n - b) -th row, the energizing controlling means also makes the voltage holding means in the n-th row discharge the voltages held thereby, and makes the scanning voltage being inputted to the scanning line in the (n - a) -th row energize the organic EL elements in the n-th row as the reverse voltage. Because of this, application of the driving voltage to the organic EL elements can be made stopped by the scanning voltage in the scanning line in the (n - b) -th row, and the organic EL elements

with energizing current being thus stopped can be energized with the scanning voltage to the scanning line in the (n - a)-th row taken as the reverse voltage. Thus, the reverse voltage can be applied to the organic EL element with the driving voltage thereof completely stopped.

[0107] Further, on inputting of the scanning voltage to the scanning line in the (n - b)-th row, the energizing controlling means makes connections between the organic EL elements in the n-th row and the power source electrodes cut off, and makes the scanning voltage inputted to the scanning line in the (n - a)-th row energize the organic EL elements in the n-th row as the reverse voltage. Because of this, application of the driving voltage to the organic EL elements can be made stopped by the scanning voltage in the scanning line in the (n - b)-th row, and the organic EL elements with energizing current being thus stopped can be energized with the scanning voltage to the scanning line in the (n - a)-th row taken as the reverse voltage. Thus, the reverse voltage can be applied to the organic EL element with the driving voltage thereof completely stopped.

[0108] Moreover, by controlling energizing of the organic EL elements in the first row with the scanning voltage to the scanning line in the N-th row of the final row, even with the arrangement in which the energizing controlling means controls energizing of the organic EL element on inputting of the scanning voltage to the scanning line in the row preceding by one, the

energizing of the organic EL elements in the first row can be controlled with a proper timing with a simple arrangement.

[0109] Furthermore, the dummy scanning voltage is inputted to the dummy line provided in parallel with the scanning line in the first row immediately before the scanning voltage for the first row, and energizing of the organic EL elements in the first row is controlled on inputting of the dummy scanning voltage to the dummy line. Because of this, even with the arrangement in which the energizing controlling means controls energizing of the organic EL element on inputting of the scanning voltage to the scanning line in the row preceding by one, the energizing of the organic EL elements in the first row can be controlled with a proper timing with a simple arrangement.

[0110] In addition, the organic EL elements in the first row, on inputting of the scanning voltage to the scanning line in the  $(N - 1)$ -th row, have the application of the driving voltage thereto stopped, and on inputting of the scanning voltage to the scanning line in the  $N$ -th row, are energized by the reverse voltage. Further, the organic EL elements in the second row, on inputting of the scanning voltage to the scanning line in an  $N$ -th row, have the application of the driving voltage thereto stopped. Because of this, even with the arrangement in which, on inputting of the scanning voltage to the scanning line in the row preceding by two, the energizing controlling means makes the application of the driving voltage to the organic EL elements

stop, and on inputting of the scanning voltage to the scanning line in the row preceding by one, makes the reverse voltage applied to the organic EL elements, the energizing of the organic EL elements in the first row and in the second row can be controlled with a proper timing with a simple arrangement.

[0111] Besides this, to the first and second dummy lines provided in parallel with the scanning line in the first row, the first and second dummy scanning voltages are inputted immediately before the scanning voltage in the first row. Therefore, the organic EL elements in the first row, on inputting of the scanning voltage to the first dummy line, have the application of the driving voltage thereto made stopped, and on inputting of the scanning voltage to the second dummy line, are energized by the reverse voltage. Furthermore, the organic EL elements in the second row, on inputting of the scanning voltage to the second dummy line, have the application of the driving voltage thereto made stopped. Because of this, even with the arrangement in which, on inputting of the scanning voltage to the scanning line in the row preceding by two, the energizing controlling means makes the application of the driving voltage to the organic EL elements stop, and on inputting of the scanning voltage to the scanning line in the row preceding by one, makes the reverse voltage applied to the organic EL elements, the energizing of the organic EL elements in the first row and in the second row can be controlled with a proper timing

with a simple arrangement.

[Brief Description of the Drawings]

[Fig. 1] A circuit diagram showing a circuit arrangement of a principal part of an EL display as a first mode of the device for displaying an image according to the invention;

[Fig. 2] A block diagram showing an entire arrangement of the EL display;

[Fig. 3] A cross sectional view showing a thin film structure of an organic EL element part;

[Fig. 4] A time chart showing signal waveforms of various parts in the EL display;

[Fig. 5] A circuit diagram showing a circuit arrangement of a principal part of an EL display as the second mode;

[Fig. 6] A time chart showing signal waveforms of various parts;

[Fig. 7] A circuit diagram showing a circuit arrangement of a principal part of an EL display as the second mode;

[Fig. 8] A time chart showing signal waveforms of various parts;

[Fig. 9] A circuit diagram showing a circuit arrangement of a principal part of an EL display as the second mode;

[Fig. 10] A time chart showing signal waveforms of various parts;

[Fig. 11] A circuit diagram showing a circuit arrangement of a principal part of an EL display of an example of variation;

[Fig. 12] A circuit diagram showing a circuit arrangement of a principal part of an EL display as the second mode;

[Fig. 13] A time chart showing signal waveforms of various parts;

[Fig. 14] A circuit diagram showing a principal part of an EL display of an example of a conventional one; and

[Fig. 15] A time chart showing signal waveforms of various parts.

[Description of the Reference Numerals and Signs]

11, 51, 61, 71, 81, 91 EL display

12 organic EL element

13 power source line as one of a pair of power source electrodes

14 grounding line as one of a pair of power source electrodes

15 driving TFT as driving transistor

16 holding capacitor as voltage holding means

17 switching TFT as switching means

18 data line

19 scanning line

20, 52, 72 to 74 controlling TFT as energizing controlling

means

21 dummy line

62 controlling capacitor as energizing controlling means

82 diode element as energizing controlling means

Fig. 1

11 EL display  
12 organic EL element  
13 power source line  
14 grounding line  
15 driving TFT  
16 holding capacitor  
17 switching TFT  
18 data line  
19 scanning line  
20 controlling TFT

Fig. 2

21 dummy line  
22 scanning driving circuit  
23 data driving circuit

Fig. 3

13 power source line  
14 grounding line  
30 glass substrate  
31 island  
32 gate oxide film  
33 gate electrode  
34 source electrode

35 drain electrode  
36 insulating layer  
41 anode  
42 hole transporting layer  
43 light emitting layer  
44 electron transporting layer  
45 cathode

Fig. 4

- (a) scanning line n - 1
- (b) scanning line n
- (c) controlling TFT Gate
- (d) switching TFT Gate
- (e) driving TFT Gate
- (f) holding capacitor
- (g) organic EL element

Fig. 5

52 controlling TFT

Fig. 6

- (a) scanning line n - 1
- (b) scanning line n
- (c) first controlling TFT Gate
- (d) switching TFT Gate

- (e) driving TFT Gate
- (f) second controlling TFT Gate
- (g) holding capacitor
- (h) organic EL element

Fig. 7

62 controlling capacitor

Fig. 8

- (a) scanning line n - 1
- (b) scanning line n
- (c) EL element

Fig. 9

Fig. 10

- (a) scanning line n - 1
- (b) scanning line n
- (c) first controlling TFT Gate
- (d) switching TFT Gate
- (e) third controlling TFT Gate
- (f) driving TFT Gate
- (g) fourth controlling TFT Gate
- (h) fifth controlling TFT Gate
- (i) holding capacitor

(j) organic EL element

Fig. 13

- (a) scanning line n - 2
- (b) scanning line n - 1
- (c) scanning line n
- (d) first controlling TFT Gate
- (e) switching TFT Gate
- (f) third controlling TFT Gate
- (g) driving TFT Gate
- (h) fourth controlling TFT Gate
- (i) fifth controlling TFT Gate
- (j) holding capacitor
- (k) organic EL element

Fig. 14

- 1 EL display
- 2 EL element
- 3 power source line
- 4 grounding line
- 6 holding capacitor
- 8 data line
- 9 scanning line

Fig. 15

- (a) scanning line  $n - 1$
- (b) scanning line  $n$
- (c) switching TFT Gate
- (d) driving TFT Gate
- (e) holding capacitor
- (f) organic EL element